Plate I.

Drawn by D. Wiest.

Drawn by D. Wiest.

Bowen & C° lith. Philada.

FIRST ANNUAL REPORT

ON THE

Noxious,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
STATE ENTOMOLOGIST.

JEFFERSON CITY, MO.,
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1869.

INTRODUCTORY.

To the Members of the Missouri State Board of Agriculture:

Gentlemen:—I herewith present my first annual report on the Noxious, Beneficial and other Insects of the State of Missouri, pursuant to your instructions of April 1st, 1868.

It is neither so full nor so valuable as I hope to make its successors, should the office be continued. This is principally owing to the fact, that but eight months have elapsed since my appointment, and that the natural history of a number of the insects that received my attention during the summer, can only be given after they have completed their transformations, which will require one, two and in some cases, even three years.

I have been exceedingly gratified at the warm reception which I have met with from all quarters. Wherever I have been, from one end of the State to the other, the cordial hand has been extended, and I have found our farmers and fruit-growers thoroughly alive to the importance of the work, for they know full well that they must fight intelligently, their tiny but mighty insect foes, if they wish reward for their labors. During the year 1868, insects injurious to our fruits have been unusually numerous, but it may well be asked whether this increase is not a meteorological effect, as was suggested by Mr. W. C. Flagg, in his *ad interim* report to the Illinois State Horticultural Society, rather than one caused by the increase of our products. The severe drouth of 1867, had a peculiarly injurious effect on many trees, and it seems quite evident that certain insects increase more rapidly in injured fruits and injured trees than in those which are healthy and vigorous. The part, indeed, which insects principally have to play in the economy of this world, is that of scavengers. They hasten the decay and dissolution of unhealthy vegetable organism, the quicker to convert it into mould, and make room for healthy plants; while they multiply at such a prodigious rate, that whenever the conditions are at all favorable to the increase of a particular species, that species appears as if by magic, over vast districts of country, and commits sad havoc to either orchard or field crops, as the case may be.

With this view of the matter, we might materially check the increase of some insects, by anticipating Nature in her operations, and cutting down such trees as have been injured from whatsoever cause, so that they shall not remain from year to year as a hiding place for noxious insects, or as a hot-bed for equally injurious funguses.

The peach crop failed pretty generally on account of the great increase of the Plum Curculio, and the opinion has been advanced and extensively published, that this insect will cause a failure of that crop in certain districts for very many years to come. Let the wise place no confidence in such predictions, for the predictors can have but a vague conception of the grand scheme of Nature, and of the laws which govern both animal and vegetable life. For many reasons unnecessary to mention, the prospect for a good crop the year succeeding an entire failure, is greater than at any other period—at least so far as insects are concerned. Because an insect is numerous and destructive one year, therefore it will be even more so the next, is apparently plausible but very fallacious reasoning. Every one of the thousands of species which are known to exist, multiplies at a sufficient rate to entirely cover our globe, in a comparatively short time, if nothing hindered; and the struggle and warfare necessary to enable all the different species to exist and hold their own, causes a constant fluctuation in the relative proportion of each. We have an illustration of this in the case of the Colorado Potato Beetle; for in those districts where it had caused so much alarm in 1866 and 1867, its enemies have so increased that it was comparatively harmless in 1868.

The importance of the study of Entomology has already become apparent to every tiller of the soil, but there is yet a class of citizens who fail to appreciate the laborious efforts of an Entomologist, and cannot conceive how the "study of bugs," as they term it, will redound to the good of a State or community. For the benefit of such, let me say, that in his last annual address the president of our State Horticultural Society, estimated the annual loss to our State from insect depredations at SIXTY MILLION DOLLARS! Now, allowing this estimate to be twice as great as the facts will warrant, the sum is yet quite enormous. It is not possible by any preventive measures to save the whole of this immense sum, but it is perfectly practicable to save a large percentage of it, and in this assertion I think the following pages will bear me out. A knowledge of the habits and transformations of insects frequently gives the clue to their easy eradication and destruction, and enables the agriculturist and horticulturist to *prevent* their ravages in the future. It likewise enables them to distinguish between their insect friends and insect enemies, and guards them against the impositions of the numerous quacks and nostrum-venders, who, with high-sounding words are constantly putting forth every energy to sell their vile compositions. Such a knowledge of insects the farmer has not time to acquire, for it is only obtained by an immense amount of hard labor in the field and anxious deliberation in the closet. Hence, the wisdom of having a State officer who can devote his whole time to the work.

Fully aware that I write for those who, as a rule, are unversed in Entomology, I have endeavored to treat of each insect with as little of the nomenclature of science as is consistent with clearness of expression. Yet, as much that is of scientific interest, such as descriptions of new species, must necessarily be inserted, I have had such descriptions printed in a type of smaller size than the text, so that it can be skipped if desirable, at the time of reading, and easily referred to for comparison, with specimens which one is desirous of naming. I have also endeavored to illustrate, as far as possible, the insects of which this report treats, believing that good illustration forms the basis of successful teaching in a science with which the general husbandman is not expected to be acquainted; for the eye conveys to the mind, in an instant, what the ear would fail to do in an hour. The practical man cares little to what genus or family an insect belongs, so long as he can tell whether it be friend or foe. He must become familiarized with the insects about him without having necessarily to overcome scientific detail and technicality.

I have made no effort at a systematic arrangement of the insects treated of. Indeed, that were useless for the purpose in view; but in order that the reader may refer the more readily to any particular insect which interests him, I have separated them into three series—Noxious, Beneficial and Innoxious—and attached a very full index. For the benefit of those who are making a study of Entomology, I have also given, with each species, the order and family to which it belongs, in parenthesis under each heading.

So far as possible, I have used a common name for each insect, knowing that the scientific name is remembered with greater difficulty, and is, consequently, distasteful to many. But as popular names are very loosely applied, and the same name often refers to different insects in different localities, a great deal of confusion would ensue without the scientific name, which is, therefore, invariably added for the most part in parenthesis, so that it may be skipped without interfering in any way with the sense of the text.

The sign ♂ wherever used in this report, is an abbreviation for the word male, the sign ♀ for female and the sign ⚲ for neuter.

Wherever the illustrations are enlarged, they are accompanied by hair-lines, which designate their natural size.

Where the measurement of an insect is given, the dimensions are expressed in inches and the fractional parts of an inch, 0.25, thus implying a quarter of an inch, and 1.25 one inch and a quarter, etc.

Many letters were addressed to me, during the summer, inquiring as to the value of the new carbolic acid, which has been so much spoken of. Having fully experimented with it during the summer, I am well pleased with it as an insect destroyer. But a word of warning in its use is necessary. It is also known by the name of cresylic acid, the difference between the two being one of purity only. Many, having seen it recommended, ordered the crude acid, and, using it—no matter how much diluted—they found to their sorrow that it killed their plants. *Carbolic acid mixes well with alkalies, but not with water, and it can only be used as a saponaceous compound.* This fact must be borne in mind by those who wish to use it.

As I shall frequently have occasion to refer to the "AMERICAN ENTOMOLOGIST," it is but proper to say, that in conjunction with Mr. Benj. D. Walsh, State Entomologist of Illinois, I commenced last September, the publication of that journal. It is devoted to Economic Entomology, and is published monthly, by R. P. Studley & Co., of St. Louis, at $1,00 per annum. We felt that pending the issuing of our annual reports, something was needed, as a more frequent means of communication with the people. The paper has received the highest encomiums from the press throughout the country, and as an enterprise has proved successful beyond our expectations—evidence of the great demand for, and need of, the kind of information which it gives.

As there must necessarily be a limit to a report of this character, I am compelled to defer till another year, accounts of the Chinch Bug, Rocky Mountain Grasshopper, and some other insects which attracted general attention during the year, and do so the more willingly, that their habits have been pretty fully given in former publications, and in the above periodical.

In conclusion, I tender my sincere thanks to those gentlemen, throughout the country, who have assisted me in one way or another, and especially to the Superintendents of the Pacific, Iron Mountain, Hannibal & St. Joseph, and North Missouri Railroads, for free passes over their respective routes.

Respectfully submitted,

CHARLES V. RILEY,
State Entomologist.

ST. LOUIS, MO., Dec. 2d, 1868.

NOXIOUS INSECTS.

THE BARK-LICE OF THE APPLE-TREE.

(Homoptera, Coccidæ.)

[Fig. 1.]

There are two species of Bark-lice that attack the Apple-tree in the United States, which I will briefly describe.

The first, which is a native North American insect, is now known as Harris's Bark-louse (*Aspidiotus Harrisii*, Walsh.) The color of the scale is dirty white, and its form is irregular, being usually egg-shaped; but, however variable in outline, it is always quite flat and causes the infested tree to wear the appearance of Figure 1; while the minute eggs which are found under it in winter time are invariably blood red or lake-red. This species has scarcely ever been known to increase sufficiently to do material damage, for the reason doubtless that there have, hitherto, always been natural enemies and parasites enough to keep it in due bounds. Though I have not witnessed it in Missouri myself, I am informed by several persons that it occurs in the northern part of the State, and a communication from R. B. Palmer, of Hartville, Wright county, published in the *Rural World*, of October 15, 1866, and stating that the lice are destroying the best apple orchards in that neighborhood, evidently refers to this species.

The second species, which is known as the Oyster-shell Bark-louse (*Aspidiotus conchiformis*, Gmélin), is by no means so harmless however, for it is one of the most pernicious and destructive insects, which the apple-grower in the Northern States has to contend with. This species presents the appearance of Figure 2, and may always be distinguished from the former by having a very uniform muscle-shaped scale of an ash-gray color (the identical color of the bark), and by these scales containing, in the winter time, not red, but pure white colored eggs.

There is scarcely an apple-orchard in Northern Illinois, in Iowa or in Wisconsin, that has not suffered more or less from its attacks, and many an one has been slowly but surely bled to death by this tiny sap-sucker. It was introduced into the Eastern States more than seventy years ago from Europe, and had already reached as far west as Wisconsin in 1840, from whence it spread at a most alarming rate, throughout the districts bordering on Lake Michigan. It occurs at the present time in Minnesota and Iowa, but whether or not it extends westward beyond the Missouri river, there are no data to show. Its extension southward is undoubtedly limited, for though so abundant in the northern half of Illinois, observation has clearly proved that it cannot exist in the southern half of the same State. I have also experimentally proved that it cannot exist in the latitude of St. Louis, the experiment being made in the following manner: On the 12th of May last, I received some scales from Jesse Hodgson, of Panola, in Woodford county, Illinois, the eggs under which were at that time hatching. Upon fastening the bark containing these scales to the twigs of a living apple-tree, that being in a position where I could easily watch them, the young bark-lice crawled actively over these living twigs, and soon fastened themselves, as is their wont, around the buds. They soon began to secrete the waxy fibres, shown at Figure 3, *a*, and in time assumed the white appearance of the first scale, which has been very aptly termed the *larval* scale by Mr. Walsh. But the growth at this point was arrested and they all soon afterwards died. As there were three twigs thickly covered, and as I could discover no parasites or cannibals of any kind, it is to my mind conclusive that THIS BARK-LOUSE CANNOT EXIST FURTHER SOUTH IN MISSOURI THAN ST. LOUIS. The experience of others is to the same effect, for Dr. Morse informs me that certain apple trees which he procured from the North, and which he planted at Kirkwood, St. Louis county, some years ago, though covered at that time with these bark-lice, are now entirely free of them; and Mr. Wm. Muir, of Fox Creek, in the same county, has had a similar experience with trees which he imported several years ago from Burrell & Co., of Lockport, N. Y., and which at the time of their receipt were very badly infested.

[Fig. 2.]

The fruit-growers of Southern Missouri, have therefore little to fear from this Oyster-shell Bark-louse, and it is not unlikely that it would die out in the country considerably north of St. Louis, if imported there; but, as it exists and flourishes near the southern border of Iowa, and extends, in Illinois, below our northern boundary, there is every reason to believe that it will flourish in the extreme northern counties of our State if once introduced there. Now, up to the present time, it has not made its appearance, as far as I can learn, in any of the orchards in that part of Missouri, and it seems that, as a State, we are entirely exempt from this most grievous orchard pest. In order to definitely decide this matter I took particular pains, while at Hannibal during the summer, to inquire of the old fruit men there on this point, and even John Fry, one of the oldest settlers, has never heard of its appearance in that vicinity. The responses from numerous letters that were sent, with the same query, to men living in other northern parts of the State, are to the same effect. Believing therefore, that this insect *can* flourish in our extreme northern counties if once introduced there, and that at present the fruit-growers of that region are exempt from it, I cannot too strongly urge them to hold the vantage ground they now have. *Let every man therefore who reads this report, and who contemplates planting an apple orchard in North Missouri, in duty to himself and to his neighbors, subject every young tree which he receives from northern or eastern nurseries, to a rigorous inspection; and if any be found infested, let them be thoroughly cleansed before planting. By this means alone, can we hope to retain that immunity, which we have so far enjoyed!*

It should indeed be a maxim with fruit growers to inspect all young trees received from a distance; for many of our very worst insect foes, such as the Canker-worm, Root-louse, etc., are undoubtedly transported from one place to another, principally on nursery stock. In order that the Oyster-shell Bark-louse may be at once recognized and thoroughly understood, I will proceed with its history:

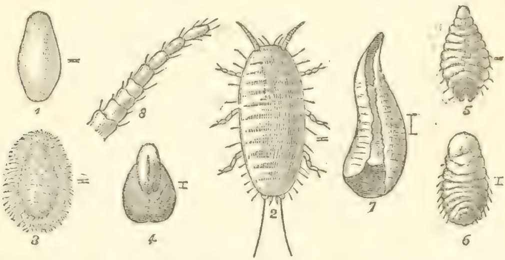
During the summer of 1867, three independent observers were closely studying the habits of this insect in Northern Illinois, unbeknown to each other, namely: Dr. H. Shimer, at Mount Carroll; Benj. D. Walsh, at Rock Island, and myself, at Chicago. Up to this time, though it had frequently been treated of, yet much that was recorded of its history was mere conjecture. For instance, Harris states that there are two broods each year, while Fitch assures us that the scales are the bodies of the gravid females, covering and protecting their eggs; neither of which is the case.

The gist of Dr. Shimer's observations which were recorded in a paper published in the Transactions of the American Entomological Society, (Vol. 1, No. 4) are, 1st—that he discovered that the tarsal joint of the newly hatched larva, which is very small, possesses no claw, but is furnished at the extremity with four fleshy hair-like processes upon which the young louse walks, and which he calls *digituli;* 2d—that the scale is constructed by the insect, and consists of the moulted skins of the louse, soldered together by some secretion which he believes to be the excrement. In these characteristics, he finds sufficient grounds for separating this insect from the Bark-louse family (COCCIDÆ) to which it has been referred by Linnæus, Gœffroy, Fabricius, Burmeister, Reaumur, Curtis, Westwood, and many other authors, and erects a new family (LEPIDOSAPHIDÆ), and a new genus (*Lepidosaphes*), to contain it. He furthermore takes it upon himself to deny what all these authors have insisted upon, viz:—that the loss of members, or the change from the perfect and active larval form represented at Figure 3, 3, to the motionless and memberless forms shown at 5 and 6 of the same figure, is an evidence of the degeneration or degradation in this insect as it approaches the imago state.

Mr. Walsh, whose observations are recorded in his First Annual Report, as Acting State Entomologist of Illinois, found nothing to induce him to separate this insect from the old genus *Aspidiotus* in the Bark-louse family, to which it had hitherto been referred. He also showed that there were three distinct growths of the scale, differing from each other in size and color, which he named respectively the "*larval scale*," "*medial scale*" and "*anal sack*." He also inclined to believe that both the "medial scale" and "anal sack" were formed "by the anal surface of the original young larva being at two successive periods abnormally dilated and extended backwards, in the form of a sack closed at tip; and that, after this process is accomplished, the insect always moults or sloughs off the whole of the external scale." As to the formation of the "larval scale" he offers no explanation.

My own observations will be found in the "Report of the Committee on Entomology," published in the Transactions of the Illinois State Horticultural Society for 1867—pp. 109–112. Having had no opportunity of continuing them the past summer, and as they will convey a good idea of this insect's mode of growth, I repeat them in part.

[Fig. 3*.]



The young lice usually leave the scales during the first week in June. Prior to their hatching, the eggs which were previously snow-white, become yellowish, and if the weather turn cool, immediately after hatching, they will remain for two or three days under the scales before dispersing over the tree. The following notes as before stated, were made in Cook County, Illinois.

June 6th.—Most of the eggs are hatched, but the young have not yet left the scales.

*These figures are highly magnified, the hair lines at their sides approximating the natural lengths. 1, egg—natural size scarcely .01. 2, larva, as it appears when running over the twigs—natural length .01. 3, its appearance soon after becoming fixed. 4, appearance of scale after the second plate is formed. 5, form of louse (ventral view) soon after losing its members. 6, form of louse (ventral view) when full grown and just about to deposit. 7, fully formed scale, containing louse, as it appears from the underside, when raised. 8, highly magnified antenna of larva, showing joints.

June 9th.—The past two days have been exceedingly warm, the thermometer rising above 90 degrees F. in the shade, and the young lice are running all over the twigs.

June 11th.—They have all become fixed, having gathered in the greatest numbers around the base of the lateral shoots of the terminal twigs.

June 12th.—A white, waxy secretion commences to issue from the body, in the shape of very fine, delicate threads (see Fig. 3, 3).

June 22d.—They have increased materially in size, the waxy secretion vanishing soon after the last date, leaving what appears to be the body, of a yellowish brown color, though in reality the body is underneath and separate, and has lost all trace of members.

July 1st.—Though watched every day, there is no perceptible change since the 22d of June.

July 2d.—They are now 0.03 long, or three times as large as when hatched, and a thin, waxy secretion commences to appear at the posterior end.

July 6th.—This secretion has increased rapidly, and taken on a somewhat oval form, with usually a slight cut or depression posteriorly. It appears quite distinct from the original yellowish-brown portion, and is duller, or of a more grayish color. On raising it carefully, the louse is seen underneath, yellowish, of a flattened form, the anterior tapering more than the posterior portion, which latter is always distinguished by having a patch of bright reddish-brown (see Fig. 3, 5). Though from analogy it must have a beak of some kind, it is so exceedingly fine and fragile that I have never been able perceive it.

July 10th.—There seems to be another pause in the growth, the scale presenting the appearance of Figure 3, 4.

July 12th.—A third plate or secretion has commenced from the posterior portion.

July 15th.—This last plate enlarges rapidly, and is the exact color of the bark.

July 20th.—The three plates are at present readily distinguished; the last, which is considerably larger than the two others together, having usually taken a slight curve, which gives the scale its characteristic form.

August 1st.—Their growth is to all appearances completed, the scale measuring 0.12, while the louse measure but 0.05, occupying thus about half the space within. The three different growths are now not readily distinguished, though the narrow end is always reddish-brown. On lifting the scale the insect does not fall out, being retained by a slight whitish fringe extending from each side of the scale (see Fig. 3, 7).

August 12th.—Some of them have commenced to deposit eggs.

August 28th.—The eggs are now, apparently, all deposited, and I have watched with interest, as the deposition went on, the body of the parent louse shrinking day by day, instead of extending and becoming gravid, until it is now a mere atom at the anterior or narrow end of the scale, in a few days scarcely to be noticed at all.

The oyster-shell bark-louse produces but one brood annually, and these eggs, therefore, remain under the scales for more than nine months of the year, subjected alike to the continuous warmth of the fall months, and to the severe frosts of winter; freezing and thawing again and again, without their vitality being in the least impaired. In order to show the conclusions which I came to, after the above observations, I will, in a measure repeat them.

All writers on this Bark-louse, copying after Fitch and others, tell you that the scale you see on your trees is the gravid body of the female insect. Now, though for aught I know the body proper of the female may, in some Coccidan species, extend and cover the eggs she deposits, it is no such thing in this instance; and I am prepared to affirm that the scale is no more the insect's gravid body than is the empty muscle shell the distended outer membrane of the muscle, or the oyster shell that of the oyster.

How this scale is formed I do not profess to have discovered. With regard to our native white species, already referred to (p. 7), Mr. Walsh, in the Practical Entomologist for December last, refutes Harris's theory, namely, that it is formed in the same way as the down which exudes from other lice, and shows, with some plausibility, that it may consist of the cast-off skins of the insect. Now, in my own humble opinion, with the imported species under consideration, I am inclined to uphold Harris, for the following reasons: besides the fine waxy filaments which it secretes when becoming fixed, I have found that, even before these are thrown out, it is covered with a fine, white bloom, proving that it can and does secrete from the general surface; having carefully lifted the scale, every day during the growth of the third portion referred to, the louse has invariably been found in the same shape and condition, without apparent connection with it, while the scale, to all appearances, actually increases in bulk during the time the eggs are being deposited. Furthermore, the exuviæ of such a tiny insect would be infinitely thinner and more delicate than is the scale, and as the insections, especially of the verter, are always plainly visible with a glass, in the louse, we should expect to see them in the scale, which is, however, perfectly smooth. Again, the louse is of the same color throughout its growth, while at one time the three parts of the scale are perceptibly different in this respect. Moreover, Reaumur long ago (Memoires, tom. IV., p. 26) observed a species occurring on the peach in France to cast its skin in flakes, much in the manner as many of our *Dipterous* and *Hymenopterous* larvæ are known to do; while he also described a species (pp. 64, 65, ibid.) occuring on the vine, which covered its eggs with a white, gummy, cottony secretion; and Mr. Walsh himself, in the February number of the little monthly already referred to, p. 57, speaking of a species occurring on the under surface of the leaves of the *Olea* *fragrans*, shows how in that species the "scale" is not formed of the lifeless body of the female, but is a distinct integument, constructed by the female to protect herself and her eggs, and probably *secreted from the general surface of the body.*

However, I believe that the entomologist will have about as difficult a task to ascertain its real mode of growth as would the physiologist to learn how the flesh on your fingers acquires its natural form. We might with equal reason try to learn why and how the thousand different excrescences and galls caused by insects are formed! Why is it that the larva hatching from an egg deposited on a rose leaf by a little four-winged fly, the *Rhodites ignota* of Osten Sacken, causes a peculiar growth or gall in the form of a mangel-wurzel, or beet seed, to surround it, while that of a similar fly, belonging to the very same genus—the *Rhodites radicum* of Osten Sacken—hatched from eggs deposited in the root of the same plant, causes an entirely different gall? Why is it that the puncture of a little yellow louse, *Pemphigus* (?) *vitifoliæ*, Fitch (or as Henry Shimer, of Mt. Carroll, would have it, *Daktylosphæra vitifoliæ*), by puncturing a grape leaf, causes an unnatural growth to surround and entomb it in the shape of the little green globular galls of different sizes, so common on Clinton grape vines, while the same sized puncture of another louse (*Aphis vitis*, Scopoli) produces no such effect? Why, again, does a little Lepidopterous larva, often found in the golden rod (the larva of *Gelechia gallæsolidaginis*, described in a future chapter of this report), produce an elongated hollow gall, while a Dipterous larva (*Trypeta solidaginis*, Fitch), in a neighboring stalk produces one that is round and solid? Or, lastly, why should the suction of different species of Dipterous larvæ (*Cecidomyiæ*), produce the wonderful galls found on our willows, causing in many instances not only a total change in the texture of the leaf, but also in its mode of growth?

To me the formation of our Bark-louse scale appears somewhat analagous to all of these, and a thousand other such phenomena known to science; and in answering how such growths, peculiar to each species, are formed, or why each is so constant in its character, I can only say that it is their nature; or, with Devere, "that knowledge of first causes belongs to Him alone, who allows the eye of man to see final causes only." The more we endeavor to study the why and the wherefore of these things the more the mind is filled with the idea of Infinity, and escaping from all visible impressions of space and time rises to sublimest contemplation of the Creator.

The growth of the scale under consideration, to my mind, depends no more on the will of the louse underneath it than does the sponge on that of the slimy, jelly-like creature which secretes it, or the coral on that of its polype; or, to use a more patent illustration, than the growth of our bones, though secreted from our organs, depends on our will.

By carefully lifting one of these scales during the months of July and August, any of you may find the true louse underneath, occupying but a portion of, and being quite separate from it.

From analogy we may presume that there are males as well as females of this species, since winged males are known to occur in the genus *Aspidiotus*, and it has been my great aim and hope to discover this gentleman. Though an extremely small percentage of the scales may generally be found dwarfed and empty during the first days of August, suggesting that a male may have escaped, yet as likely as not these may have been killed by some cause or other. In the latter part of June I counted five hundred scales on a single twig, and marked them to prevent mistake or confusion in recognizing them again. After watching them steadily, and carefully lifting each one on the 28th of August, they all, with the exception of two, were found to contain eggs. The same average would doubtless have been found over the whole tree; and from this fact I am constrained to believe that as a rule no males appear, and that if there be exceptions where they do occur, they are in such proportion as to be of little avail. Mr. Shimer, in speaking of the Clinton grape gall, already alluded to, states that he opened thousands of them before he found a male; and it is difficult to conceive what effect a single delicate male, shut up in a gall, could have on the thousands of others not dignified by his presence. When we reflect on the abnormities occurring among our plant-lice, I see no reason why our bark-lice should not be hermaphrodite as a rule, and yet occasionally produce males. They are still lower in the scale of Nature than the plant-lice, and one of them—the celebrated Cochineal—puzzled naturalists a long time as to whether it was a plant or an animal. There is in fact so much of the anomalous about this family that it furnishes a rich and interesting field of study.

The observations of both, Mr. Shimer, Mr. Walsh, and myself agreed as to the time of hatching; as to the mode of growth of the scale, and as to finding no females; but as to the process by which the scale was formed there was difference of opinion. The reason, it seems to me, is obvious enough: in attempting to elucidate the problem we reach beyond the limits of our power of perception into the realms of conjecture. It is easy enough to watch the mode of growth of an oak-apple, but it is not such an easy matter to ascertain the reason why the kind which occurs on the red oak (produced by *Cynips quercus-inanis*) should form inside with radiating spokes from a common central cell; while that on the black oak (produced by *Cynips*? *quercus-spongifica*) should form inside with a dense spongy substance around a similar central cell. Mr. Shimer may, in part, be right in stating that the larval scale is formed by the young louse shedding its skin; but the extremely fine skin alone would not form such a scale, and he strangely overlooks the wax-like filaments secreted from the general surface of the body as well as the peculiar distinction in the growth of the "medial" and "anal" sacks. That these two last scales are *constructed* by the louse, of its own cast skins and some excrementitious secretion, as he suggests, is also made *extremely* doubtful, from the simple fact that you may raise them every day of their growth and find the louse underneath, entirely free and separate. But after all, though of great scientific interest this matter is of no practical importance whatever, for as we shall see hereafter the great point to be borne in mind, in a practical light, is the time of hatching of the egg.

As the female Bark-louse is only capable of motion for a period of from two to three days at the most, after which time she becomes as permanently fixed for the rest of her life as is the tree on which she is fastened; and as the winged males (even if they ever exist) could not assist in the spread of the species, it may puzzle some to divine how this insect spreads from tree to tree and place to place. That it is transported to distant places, mainly on young trees, there can be no doubt, and there are various ways in which it can spread from tree to tree in the same orchard, though it can only thus spread during the few days of its active larval state. Mr. Walsh believes that the only way, as a general rule, that it can spread from tree to tree, when the boughs of those trees do not absolutely interlock, is by a few of these active young larvæ, crawling accidentally on to the legs of some bird, that chances to light on one tree and afterwards flies to another, and he even goes so far as to say that he believes this Bark-louse would soon cease to exist, if all the birds in the world were killed off (Rep. p. 41). My friend Walsh seems to have a special grudge against the birds, and it is hard to imagine how he could make such a statement, in face of the fact that where there is one bird, there are a hundred insects roaming constantly from tree to tree, that are just as capable of giving the young lice a lift. Moreover the specific gravity of the young louse is so slight that it almost floats in the air, and is undoubtedly aided in spreading by the winds; while on a tree very thickly covered with old scales, its traveling propensities are sufficiently developed to cause it to run down the trunk of the tree and *even over the ground*, and as it travels at the rate of two or three inches per minute, it could manage to measure several rods with its microscopic legs, in the course of its active state.

Though essentially belonging to the apple tree, this Muscle-shaped bark-louse is not unfrequently found both upon the Currant, the Plum and the Pear. I have seen the scales fully developed and bearing healthy eggs *on the fruit* of the White Doyenne pear, of the Transcendent crab, and of the wild plum (*Prunus Americana*) which have been sent to me by Mr. T. D. Plumb, of the State Journal, Madison, Wisconsin; and, though on the hard bark of a tree, we cannot judge of the amount of sap they absorb, it is quite apparent on these soft fruits, for each scale causes a considerable depression from the general surface. I have also received twigs of the Persian lilac from

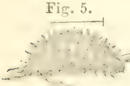
F. Starr, of Alton, Illinois, covered with a species, which, if not the same, is exceedingly like it.

NATURAL REMEDIES.—It was last year simultaneously discovered by Mr. Walsh and Mr. Shimer, that a species of mite (*Acarus* family) preyed unmercifully on the louse as well as on its eggs. This mite was described by Mr. Shimer as *Acarus malus* in the paper already referred to, and it appears that it greatly resembles the young bark-lice. Mites are not true insects, but belong to the same class (*Arachnida*) to which our spiders belong, and although the species are numerous—some causing galls on plants, some living externally on vegetable substances and seeds, either in a sound or rotten condition, others devouring animal substances, both dead and living, while others again are parasitic on certain animals—yet they all are readily distinguished in the perfect state from true insects by having four pairs of legs, and by the head and thorax being soldered in one piece without any joint whatever. Some of them, in the larval state, have but six legs, thus still more closely mimicking the young bark-lice, but they all acquire eight in the full grown state. This mite, so insignificant that in the larval state it can only be noticed by careful watching with a pocket-lens, has, doubtless, done more to save the apple trees in the Northern States than any one thing else; and its existence explains the gradual decrease of the Bark-louse that is known to have occurred in many orchards, and also accounts for its entire extermination on certain trees.

Fig. 4.

The next most efficient aid we have is the Twice-stabbed lady-bird (*Chilocorus bivulnerus*, Muls.) This good friend is readily recognized by its polished black color, and the blood-red spot on each wing-case. It is represented magnified at Figure 4, the hair line at the side showing the natural length. Its larva (Fig. 5) is a dark gray prickly affair, and is extremely active and voracious. In changing to pupa, the larval skin splits open on the back, but the naked pupa, which is of the color of burnt-umber with lighter sides, remains within it as if for protection. In this latter state these lady-birds may often be found fastened in clusters of from six to twenty on apple trees affected with either kind of bark-louse, and they should invariably be protected. It is astonishing how rapidly they will cleanse a tree from its vermin, and there is no better way of getting rid of bark-lice than by introducing a few of these little friends onto the lousy tree.

Fig. 5.



ARTIFICIAL REMEDIES.—These may be summed up in a very few words, and consist, for the most part, in prevention, and I again urge a strict examination of every young tree before it is planted. If an orchard is once attacked before its owner is aware of it, much could be done on young tress by scraping the scales off in winter, but on large trees where it is difficult to reach all the terminal twigs, this method becomes altogether impracticable, and it will avail but little to cleanse the trunk alone, as most of the scales containing living eggs will be found on the terminal branches. Alkaline washes, and all other washes, except those of an oily nature, such as petroleum or kerosene, are of no avail when applied to the scales, for the simple reason that they do not penetrate and reach the eggs which are so well protected by these scales; and it is very doubtful whether any solution can be used that is sufficiently oily to penetrate the scales and kill the eggs without injuring the tree, especially while the sap of the tree is inactive. Hence, this Bark-louse can only be successfully fought at the time the eggs are hatching, and the young lice are crawling over the limbs. The time of year in which this occurs has already been indicated, and the trees should be closely watched during the last days of May and the first days of June, for, without close scrutiny, they will not be observed, appearing simply like very minute, white, moving specks. While the young larvæ are thus crawling over the tree, they are so tender that they can be readily destroyed by simply scrubbing the limbs with a stiff brush. It it quite evident, however, that any remedy, to become practicable on a large scale, so as to rapidly and effectually reach every limb of the tree, both large and small, must be applied by a syringe or by means of fumigation, and that whatever be applied, it must kill the lice without injuring the foliage or fruit, as the young apples are generally as large as a good sized pea by the time the lice hatch. Fumigation has not yet been sufficiently tried to enable us to judge of its merits. A correspondent of the *Prairie Farmer*, in recommending brimstone, gives the following as his plan of using it: "My plan is to cover the entire tree with cloth, so that there are no holes to let out the smoke; take an iron dish—a frying pan with a handle, if you please—put in about one pound of roll brimstone (not sulphur), heat a chunk of iron red hot—say a clock weight; drop the iron upon the brimstone, and put it under the tent cloth, where it should remain long enough to fairly smudge the whole tree. More brimstone can be added, and the iron repeated as often as desired, probably five minutes to a tree would be sufficient, more would do no harm. The cloth can be easily taken off and put on by two operators, each with a light pole with a spike in the end. The one pound of brimstone will burn about an hour." Having had no bark lice on which to try the above experiment, I wrote to the party recommending it, and as I received no answer, the experiment probably failed or was never tried. The brimstone would doubtless injure the tree.

Mr. A. R. Whitney, of Franklin Grove, Lee county, Illinois, whose apple trees have been troubled more or less with bark lice, found that an application of sheep manure around the trees, had a beneficial effect in checking the pests, and he attributes the result to the ammonia arising from the manure. With regard to washes, to be used with a syringe, the late Dr. Jno. A. Kennicott used 1 lb. of sal soda to one gallon of water with good effect; it is best used by heating 0 redness in an iron pot and then dissolving it in the water. Mr. E. G. Mygatt, of Richmond, McHenry county, Illinois, has experimented with this insect for over 20 years with the following result: Brine (2 quarts salt to 8 of water) kills the lice, but also the foliage and fruit. Tobacco water (strong decoction) neither injures the foliage nor affects the lice. A solution of cobalt kills the lice, but takes the foliage also. Weak lye kills the lice, but also somewhat affects the leaves. Lime water kills about half the lice, and affects the leaves a little. Finally, quassia, boiled in proportion of 1 pound to 3 gallons of water, though well known to be effectual for the common plant-lice, has no effect on these coccids. In short, we have abundant proof that neither tobacco-water nor strong alkaline washes have any effect on these young lice, though a strong solution of soap *will* kill them, and my experience the past season, with cresylic acid soap in other directions, leads me to strongly recommend it for this purpose. It will sometimes be necessary to repeat the wash, as the lice do not all hatch out the same day, though the period of hatching seldom extends over three days.

From the foregoing it is obvious that bark-lice can only be successfully fought during three or four days of the year: how absurd and ridiculous then, are all the patent nostrums and compounds which are continuously offered to the public as perfect "bark-lice extinguishers," and which never mention this most important fact. May this insight into the history of the Apple tree Bark lice, prevent many a man from being swindled out of his time and money by these impostors!

THE PERIODICAL CICADA.

(Homoptera Cicadidæ.)

SEVENTEEN AND THIRTEEN YEAR BROODS.

The year 1868 will long be remembered in the annals of insect life, as one of peculiar interest, from the fact that this singular Cicada (*Cicada septendecim*, Linn.) popularly known as the "17-year locust," made its appearance very generally over the United States.

The metamorphoses of insects, their instructive industry, their quarrels and their instincts, afford abundant food for our love of the marvelous; but few of them can claim such a singular history as can our Periodical Cicada. We are moved to admiration in contemplating the fact that an insect, after living for 17 long years in the bowels of the earth, should at last change its sluggish, creeping and worm-like form, and, endowed with the power of flight, ascend from its earthy retreat to become a denizen of the air and to enjoy the full glory of the Sun. But our wonder increases when we reflect that this same insect has appeared in some part or other of the United States at regular intervals of 17 years, for centuries, aye! for ages in the past. Long ere Columbus trod on American soil this lowly insect must have appeared regularly at its appointed time. It must have filled the woods with its rattling song, when none but wild beasts and savages were present to hear it. To me there is something beautiful in the idea that through its periodicity we are enabled with tolerable certainty to go back in thought, for centuries in the past, to a particular month of a particular year, when the woods resounded with its song in the same manner as they did last summer; for so regularly do the different broods appear, that one is perfectly warranted in the assumption, that in the month of June, in the year 1738, for instance, 130 years ago—they appeared in the southern part of Missouri, and that 6 years previously they had appeared in the northwestern corner of the same State.

Though so much had hitherto been written about this Cicada, yet some of the most interesting facts with regard to it were unknown till the past season. A very complete article on the subject was published in the December number of the AMERICAN ENTOMOLOGIST, which I shall for the most part repeat, and render more complete by the addition of some facts as to their distribution, which were contained in some unpublished manuscript of the late Dr. Gideon B. Smith, of Baltimore, Md., and which were communicated to me through the kindness of Dr. J. G. Morris of the same city.

It was my good fortune to discover that besides the 17-year broods, the appearance of one of which was recorded as long ago as 1633, there are also 13-year broods;* and that, though both sometimes occur in the same States, yet, in general terms, the 17-year broods may be said to belong to the Northern, and the 13-year broods to the Southern States, the dividing line being about latitude 38°, though in some places the 17-year brood extends below this line, while in Illinois the 13-year brood runs up considerably beyond it. It was also exceedingly gratifying to find, four months after I had published this fact, that the same discovery had been made years before by Dr. Smith, though it had never been given to the world.

It so happened that one of the largest 17-year broods, together with one of the largest 13-year broods, appeared simultaneously in the summer of 1868. Such an event, so far as regards these two particular broods, has not taken place since the year 1647, nor will it take place again till the year 2089.

There are absolutely no perceptible specific differences between the 17-year and the 13-year broods, other than in the time of maturing; but whether or not, scientifically speaking, they are to be considered as specifically distinct, the 13-year brood may, for convenience sake, be called *Cicada tredecim*, in contradistinction to *Cicada septendecim*,

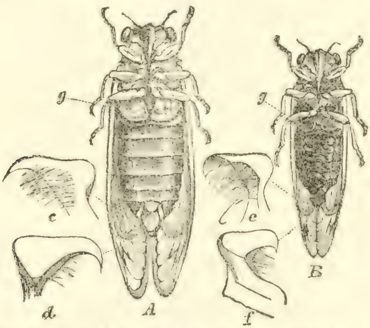
* See *Journal of Agriculture*, St. Louis, June 13, 1868, in which appeared the first account ever published of such a brood.

the 17 year brood. Mr. Walsh informs me that Charles Darwin, Prof. Asa Gray, and Dr. Hooker all agree in the belief that the 17-year and the 13-year forms ought not to be ranked as distinct species, unless other differences besides the period of development could be discovered, the mere rarity of variability in such a point not being sufficient.

TWO DISTINCT FORMS.

It is not a little singular, also, that two distinct forms occur in both broods—a large one and a small one—the former by far more numerous than the latter. This fact has been observed in past years, and was noticed the present year by independent observers in different parts of the country.† Indeed, it was observed by Dr. Hildreth, of Marietta, Ohio, as far back as 1830 (vide Silliman's Journal XVIII, p. 47). The true *Cicada septendecim* of Linnæus (Fig. 6 *A*, ventral view of male), as described by Harris and Fitch, occurs in the greatest numbers, both in the 17 and 13-year broods. It will measure, on an average, one and a half inches from the head to tip of the closed wings, and almost always expands over three inches. The whole under side of the abdomen is of a dull orange-brown color, and in

[Fig 6.]



the male more especially, four or five of the segments are edged with the same color on the back.

The other form (Fig. 6 *B*, ventral view of male) is not, on an average, much more than two-thirds as large, and usually lacks entirely the dull orange abdominal marks, though there is sometimes a faint trace of them on the edges of the segments beneath. This small form was described in 1851, by Dr. J. C. Fisher, in the Proceedings of the "Philadelphia Academy of Natural Sciences," Vol. V, pp. 272-3, as a new species of

† 1. Mr. V. T. Chambers, in the August number of the "American Naturalist," p. 332, is said to point out some variation in color from those described by Dr. Fitch.

2. Mr. S. S. Rathvon favored me with specimens of both species from Lancaster county, Pa., accompanied with the following: "I am justified, I think, in concluding these are two distinct species. They are different in size and coloration, produce entirely different stridulation, do not cohabit indiscriminately," etc.

3. The correspondent to the Department of Agriculture (July Rep.) from Hematite, Mo., says: "There are two species, one (both male and female) about twice the size of the other, and differing greatly, also, in their cries and actions."

Cicada, hitherto confounded with *septemdecim*, and was named *Cicada cassinii.* His description was followed by a note from Mr. John Cassin, in which he states that the two forms show no disposition to associate together, and produce very different cries. The fact of the very great difference in the song of the males has been fully confirmed by the observations of M. C. Hill, of Northeast Ohio, who likewise found that the small form is very much less numerous than the large one.

The truest test of the specific distinction of these two forms lies in the comparative shape of the male genital hooks, and on submitting specimens of both forms to Dr. H. Hagen, of Cambridge, Mass., formerly of Köenigsburg, Prussia, he very kindly furnished the drawings *c*, *d*, *e*, and *f*, in Figure 6, which show the male genital hooks of both. That of *septemdecim* is represented on the outside at *c*, on the inside at *d*; and that of *cassinii* on the outside at *e*, and on the inside at *f*.

By these figures, it will be seen that there are sufficient differences to separate the two forms as distinct; but while the hooks of the large kind (*septemdecim*) are quite constant in their appearances those of the smaller kind (*cassinii*) are variable, and in some few specimens are undistinguishable from those of the large kind. This circumstance, coupled with the fact that the small kind regularly occurs with both the 17 and 13-year broods, would indicate it to be a dimorphous form of the larger, or true periodical species; especially when we consider that dimorphism and heteromorphism are not uncommon among the true Bugs (HEMIPTERA). Mr. P. R. Uhler, of Baltimore, Md., who has given this order of insects particular attention, informs me that he is not fully satisfied of the specific distinctness of *C. cassinii*; but Dr. Hagen thinks there is no possible doubt of its being distinct, for the simple reasons, as he states, that dimorphism occurs only in one sex, while here both sexes are involved; that *cassinii* appears later, makes a different noise, has different colors and was never seen to copulate with *septemdecim*. To use Dr. Hagen's own words, "what more is needed to make a distinct species, if one kind of Cicada requires 17 years to undergo its transformations, why not a second kind?" I find among a great number of specimens, which I have examined, that not only do the hooks of *cassinii* vary, but the other characters that have been mentioned as belonging to it, are variable, there being perfectly intermediate grades between its extreme type and that of *septemdecim*. Again, on the supposition that it is a distinct species, the chances are extremely small, of its issuing together with *septemdecim* in the *same* year in the many different localities hereafter mentioned. Therefore, though it will be convenient to use the two names, I think the two forms should not be ranked as distinct. But the discussion of the subject would involve the general problem of specific character.

The large species has been observed to make its appearance from eight to ten days earlier than the small species (*cassinii*), and there is not a single specimen of the latter, among a number of the 13-year brood (*tredecim*) that I captured in May, though I took a few specimens afterwards.

THE SEASON OF THEIR APPEARANCE AND DISAPPEARANCE

differs somewhat with the latitude, though not so materially as one might suppose. According to the records, they appeared the past season earlier in the South than in the North; but the last half of May can be set down as the period during which they emerge from the ground, in any part of the country, while they generally leave by the 4th of July. In St. Louis county the past season they commenced issuing on the 22d of May, and by the 28th of the same month, the woods resounded with the rattling concourse of the perfect insect. As is the case with a great many other insects, the males make their appearance several days before the females, and also disappear sooner. Hence in the latter part of the Cicada season, though the woods are still full of females, the song of but very few males will be heard.

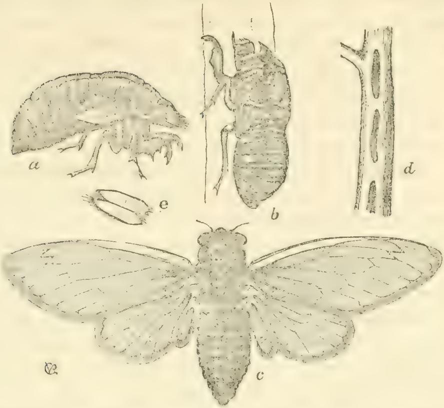
That circumstances favorable or otherwise may accelerate or retard their devolopment, was accidently proven, the past season, by Dr. E. S. Hull, of Alton, Illinois; as by constructing underground flues, for the purpose of forcing vegetables, he also caused the Cicadas to issue as early as the 20th of March, and at consecutive periods afterwards, till May, though strange to say these premature individuals did not sing. They frequently appear in small numbers, and more rarely in large numbers, the year before or the year after their proper period. This is more especially the case with the 13-year brood. Thus in Madison county in Illinois, and in Daviess and Clark counties in Missouri, there were in 1854 a few precursors to the true 1855 brood. They were also observed in Madison county, Illinois, in 1867; while "L. W." writing from Guntersville, Alabama, to the *Country Gentlemen* of June 25, 1868, says, "some call them 14-year locusts." Other such cases will be noticed hereafter.

THEIR NATURAL HISTORY AND TRANSFORMATIONS

have been sufficiently described in the standard works of both Harris and Fitch, and it is only necessary to mention a few facts not recorded by them.

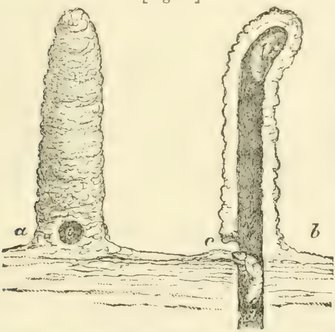
Mr. S. S. Rathvon, of Lancaster, Pa., who has himself witnessed four of their periodical visits, at intervals of 17 years, discovered the following very ingenious provision which the pupæ (Fig. 7, *a*) made the past season, in localities that were low or flat, and in which the drainage was imperfect. He says: "We had a series of heavy rains here about the time of their first appearance, and in such places and under such circumstances, the pupas would continue their galleries from four to six inches above ground (Fig. 8, *a* full view, *b* sectional

[Fig. 7.]



view), leaving an orifice of egress even with the surface (Fig. 8, *e*).—In the upper end of these chambers the pupas would be found awaiting their approaching time of change (Fig. 8, *c*). They would then back down to below the level of the earth, as at *d*, and issuing forth from the orifice, would attach themselves to the first object at hand and undergo their transformations in the usual manner." Mr. Rathvon kindly furnished me with one of these elevated chambers, from which the above drawings were taken. It measured about four inches in length, with a diameter on the inside of five-eighths of an inch, and on the outside of about one and a quarter inches. It was slightly bent at the top and sufficiently hard to carry through the mail without breaking. The inside was roughened with the imprints of the spines with which the fore legs of the builder are armed. In a field that was being ploughed near St. Louis, about the time of their ascent, I found that single, straight or bent chambers were the most common, though there were sometimes several branching near the surface from a main chamber below, each of the branches containing a pupa. The same observations have been made by other parties. These holes are cylindrical and are evidently made by oppressing the earth on all sides and throwing the refuse to the bottom, which must be quite a feat when they penetrate hard roads or come up between two rocks as they frequently do.

[Fig. 8.]



The larvæ are frequently found at a great depth, nothwithstanding its denial. Thus Mr. Henry Sadorus of Port Byron, Illinois, who built a house in 1853, found that they came up through the bottom of his cellar in 1854, the cellar being over five feet deep, and Mr. F. Guy of Sulphur Springs informed me that he had found them at a depth of ten feet below the surface.

When ready to transform they invariably attach themselves to some object, and, after the fly has evolved, the pupa skin is left still adhering, as shown at Figure 7 *b*. The operation of emerging from the pupa most generally takes place between the hours of 6 and 9 P. M.; and ten minutes after the pupa skin bursts on the back the Cicada will have entirely freed itself from it. Immediately after leaving the pupa skin, the body is soft and white, with the exception of a black patch on the prothorax. The wings are developed in less than an hour, but the natural colors of the body are not acquired till several hours have elapsed. These recently developed Cicadas are somewhat dull for a day or so after transforming, but soon become more active, both in flight and song, as their muscles harden. For those who are not informed of the fact, I will state that the males alone are capable of "singing," and that they are true ventriloquists, their rattling noise being produced by a system of muscles in the lower part of the body, which work on the drums under the wings, shown in Figure 6, at *gg*, by alternately tightening and loosening them. The general noise, on approaching the infested woods, is a compromise between that of a distant threshing machine and a distant frog pond. That which they make when disturbed mimics a nest of young snakes or young birds under similar circumstances—a sort of scream. They can also produce a chirp somewhat like that of a cricket's, and a very loud shrill screech, prolonged for fifteen or twenty seconds, and gradually increasing in force and then decreasing.

After pairing, the females deposit their eggs in the twigs of different trees; and though for this purpose they seem to prefer the oaks and the hickories, they oviposit in almost every kind of deciduous tree, and even in herbaceous plants, and in evergreens. We have seen their eggs in the Chestnut, Locust, Willow and Cottonwood, in peach twigs of not more than $\frac{1}{8}$ inch diameter, and also in the stems of the common Eupatorium, while R. H. Warder, of Cleves, Ohio, has found them in the following evergreens: Thuja occidentalis, Juniperus virginiana and Abies canadensis, but was unable to find any traces of their work in either of our common pines—Pinus Austriaca, P. strobus or P. sylvestris.

Dr. Harris (*Inj. Ins.* p. 212) has well described the mode of depositing, and it is only necessary to add that the female always saws with her head upwards, *i. e.* towards the terminal part of the branch, except when she comes in contact with a side shoot, when, instead of

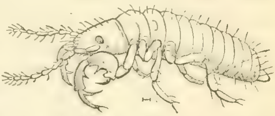
[Fig. 9.]

[Fig

shifting a little to one side, she reverses her position, and makes two punctures in an opposite direction to the rest, and thus fills up the straight row close to the base of the side shoot. The eggs (Fig. 7 *e*) are of a pearl white color, one-twelfth of an inch long, and taper to an obtuse point at each end. They are deposited in pairs, but separated by a strip of wood, which is wider —and thus causes the eggs to be further apart—at the bottom of the grooves than at their commencement. The punctured twigs bear the appearance of Figure 9, and frequently break off and die, though the great majority remain green and recover from their wounds. Indeed, there is every reason to believe that the eggs seldom hatch in those twigs which break off and become dry, but that the life and moisture of the twig is essential to their life and development of the egg, for the eggs are noticeably larger just before hatching than when first deposited, showing that they are, to a certain extent, nourished by the living wood, as is the case with those of many Saw-flies. Mr. Rathvon has also recorded the fact that the Cicada eggs are always shriveled in twigs that are amputated by the Oak-pruner (*Stenocorus villosus*, Fabr.) In the healing of the punctured parts a knot usually forms over each puncture, and I represent, at Figure 10, a portion of an apple twig, sent to me by Mr. John P. McCartney, of Cameron, in Clinton county, and which was punctured in the year 1862. Though the wounds had so well healed on the outside, the grooves inside were not filled up, but still contained the minute glistening egg-shells, from which the young larvæ had escaped six years before.

The eggs hatch between the 20th of July and the 1st of August or in about six weeks after being deposited. The newly hatched larva (Fig. 11) differs considerably from the full grown larva, but principally in having much longer and distinctly 8-jointed antennæ.* It is quite active, and moves its antennæ as dexterously and as rapidly as does an ant. As soon as it has extricated itself from an exceedingly fine membrane, which still envelops it after it has left the egg,† our little Cicada drops deliberately to the ground; its specific gravity being so insignificant, that it falls through the air as gently and as softly as does a feather.

[Fig. 11.]



The cross veins near the tip end of the upper wings of the Periodical Cicada form a dusky zig-zag mark in the shape of a W. Some ignorant persons are silly enough to believe that this mark portends

*There is frequently a ninth joint partly developed.

†All young Grasshoppers and Katydids that I have ever hatched were invariably enveloped in a like membrane after leaving the egg, and until this is thrown off the young insect is awkward in its motions. In the case of the young Cicada, these fine membranes are usually left attached to the roughened orifice of their nidus, and thus form, together, a white glistening bunch.

war. It occurs alike, though not to such a marked degree, on all other Cicadas, and if people must have an omen let them rather take the two W's for *warm weather*, and it will not be likely to disappoint them.

ENEMIES OF THE CICADA.

Upon leaving the ground to transform, the pupæ are attacked by different quadrupeds, by birds, by cannibal insects, such as Ground-beetles, Dragon-flies, Soldier-bugs, etc.; while hogs and poultry of all kinds greedily feast upon them. In the perfect fly state they are attacked by at least one insect parasite; for dipterous maggots (the larvæ, probably, of some Tachina fly) may occasionally be found in their bodies. In this state they are also often attacked by a peculiar fungus, which was first described by Dr. Leidy, in the Proceedings of the Philadelphia Academy of Natural Sciences for 1851. Dr. W. D. Hartman, of Westchester, Pa., speaking of the occurrence of this fungus, in 1851, says: "The posterior part of the abdomen, in a large number of male locusts, was filled by a greenish fungus. * * * The abdomen of the infected males was unusually inflated, dry and brittle, *and totally dead while the insect was yet flying about.* Upon breaking off the hind part of the abdomen, the dust-like spores would fly as from a small puff-ball." One male specimen received the present year from Pennsylvania was affected by the same, or a similar fungus, the internal parts of the abdomen being converted into what appeared to be a brown mould.

R. H. Warder, of Cleves, Ohio, in speaking of this mould says: It seemed to be a drying up of the contents and membranes of the abdomen, generally of a brown color, and dry and brittle. I found that in many cases the male organs of generation remained so firmly attached to the female during copulation that the male could only disengage himself by breaking away, leaving one or two posterior joints attached to the female, and it is these mutilated males which I found affected by the peculiar fungus mentioned, and therefore concluded that the "dry rot" might be the result of the broken membranes. I never found one thus affected in the very early part of their season, and I never found a perfect male thus affected. But this is not positive proof.

THE STING OF THE PERIODICAL CICADA.

It is astonishing what a wide-spread fear exists of the Cicada on account of its stinging powers. There is scarcely a paper in the United States but published some account of a "locust" sting last summer, while unpublished accounts were equally numerous. One of the editors of the St. Louis *Republican* was kind enough to clip out for me all accounts of such stings, which he found in their numerous exchanges, and the number which had accumulated, before the end of the "Locust" season, was truly surprising. Some people even denied themselves the pleasure of eating blackberries, raspberries and other fruits, because they feared these fruits had been poisoned by the eggs of Cicadas; while others believed that they poisoned water. I have endeavored to trace up a number of these reports, but have invariably found that they were either false or greatly exaggerated, and there is no doubt whatever that the great majority of such accounts owe their origin to the fertile imaginations of newspaper reporters, who are ever ready to create a sensation. Yet, to use a common metaphor, it is strange there should be so much smoke and no fire, and I will briefly review the only three methods by which such stinging can possibly be produced. At the same time, I give it as my conviction that there is but little cause for fear, as I have handled hundreds of them, and know hundreds of persons, including children, who have done the same, and yet have never been able myself to witness a single case of *bona fide* stinging,

By Hornets.—There is a very large Digger wasp (*Stizus grandis*, Say), represented of the natural size in the accompanying Figure 12, whose peculiar habit it is to provision its nests with Cicadas. The burrows made by this Digger wasp, or hornet, are about three feet long, with two or three galleries about one foot long, each terminating in a chamber considerably enlarged. The female catches a Cicada which she stings and paralyzes, and drags into one of these chambers; and it is not very unlikely that she should occasionally alight on some human being with a Cicada in her grasp, and upon being brushed off, should retaliate by stinging the offender, and then fly off, leaving the Cicada behind, which, in absence of the hornet, would very naturally be accused of the sting. An allied species of Digger wasp (the *Stizus speciosus* of Say) has been actually observed, by Mr. Rathvon, to carry off a few belated individuals of the Periodical Cicada; but the usual prey of both these species is the larger annual Cicada (*C. pruinosa*, Say), and they both occur too late in the season to be the cause of all the stinging we hear of.

[Fig. 12.]

By the Ovipositor.—The ovipositor of the female (Fig. 13, *b*) is certainly capable of inflicting a wound, but the Cicada is anything but pugnacious, and when not in the act of ovipositing, this instrument is securely enclosed in its sheath. That this is the stinging instrument is rendered extremely doubtful, for the following reasons: 1st. All the stinging we hear of has been done suddenly, while the insertion of the ovipositor would necessarily be a gradual operation, requiring at least one minute; 2d. The real function of the ovipositor is to convey an egg into the wound which it makes, and I have been unable to trace a single case where eggs were found in the flesh. All such accounts have proved to be fabrications, and the straightforward report which Mr. V. T. Chambers, of Covington, Ky., gave inthe August number of the *American Naturalist*, of a negro being stung on the foot by a Cicada, proved, after all, to be a mistake, for "Mr. Winston did not see the insect with its instrument *in situ*;" 3d the three following facts, which are reliable, prove that stinging in the usual sense of the term, by this instrument is almost impossible: First, Mr. Wm. Muir, associate editor of Colman's *Rural World*, carefully lifted a female from off a tree, while she was yet in the act of ovipositing, and as carefully placed her on his little finger, holding it as near as possible in the same direction and position as the branch grew from which she was taken. She instinctively endeavored to continue ovipositing, and, holding firmly to his finger, tried again and again to insert the ovipositor, but without the least success, for it could not make the least impression on the soft and yielding flesh, but continually slipped from one side to the other. Second, it is recorded that Mr. Peter A. Brown, of Philadelphia, Pa., himself inflicted a puncture with the ovipositor, several times, upon his hand, without experiencing any more pain than that produced by a prick of a pin or any other pointed instrument, and that no swelling ensued; third, Dr. Hartman, of Pennsylvania, introduced some of the moisture from the ovipositor into an open wound and it caused no inflammation whatever.

[Fig. 13.]

By the Beak, or Haustellum.—The beak (Fig. 13, *a*) is an organ which both sexes of the Cicada possess, and by which they take their nourishment. I have seen them insert it into and extricate it from the branches of different trees, and know that the operation is quite rapid, and that the instrument must be quite sharp and strong. All the more authentic cases of stinging, indicate this to be the instrument,* and it is quite likely that, just as the sting of a bee will affect some persons nigh unto death, and have no effect whatever on others, so the puncture of the beak of a Cicada will be more serious with some than with others. That there is no poison

*Mr. D. B. Wier, of Lacon, Ills., who well knows the difference between the male and female Cicada, recollects distinctly, that when they were there in 1854, he was stung in the finger by the male, the sting not causing very severe pain.

Mr. R. T. Parker, of St. James, Phelps county, Mo., an intelligent fruit grower, who has given some time to the study of insects, informed me that he was stung on the neck by a male Cicada, evidently with the beak, and that the sting was not so painful as that of a bee.

Dr. M. M. Kenzie, of Centerville, Reynolds county, Mo., has communicated the fact that Frank Smith, aged 14 years, living on Henpeck, in the lower part of Reynolds county, was stung by a Cicada on the back of the left hand. The wound healed by first intention, and the next morning there was only a black clot, *about the size of a pin's head*, to mark its place, with scarcely any swelling.

gland attached to this beak, is no argument against its stinging power for several true Bugs are known to produce severe stings by their beaks, while the hairs and spines of some caterpillars have a similar power.

THE INJURY WHICH CICADAS CAUSE TO FRUIT TREES.—REMEDIES.

While living under ground they have been accused of killing pear trees, and more especially by Miss Margaretta H. Morris, in accounts of them published in 1846. The late Dr. Smith, of Baltimore, however, who made extensive operations, denied their being capable of such injury. He says:

"The larva obtains its food from the small vegetable radicals that everywhere pervade the fertile earth. It takes its food from the surface of these roots, consisting of the moist exudation (like animal perspiration), for which purpose its rostrum or snout is provided with three exceedingly delicate capillaries or hairs which project from the tube of the snout, and sweep over the surface, gathering up the minute drops of moisture. This is its only food. The mode of taking it can be seen by a good glass."—*In Prairie Farmer, December*, 1851.

While they can, if they wish, insert their beaks into roots, and very likely do so in some cases, yet I incline to believe, that Dr. Smith's views are correct, for though Dr. Hull, of Alton, Illinois, has often found them firmly attached to different roots by the legs, he has never found the beaks inserted. The fact that they will rise from land which has been cleared of timber, cultivated, and even built upon for over a dozen years, certainly contravenes Miss Morris's statement, while their long subterranean existence precludes the necessity of rapid suction. It is also quite certain that if they thus killed trees, we should oftener hear of it, and I have captured a gigantic but unnamed species of Cicada on the plains of Colorado, 50 miles from any tree, other than a few scattering willows.

In the perfect state, however, the female is capable of doing great injury to trees by hacking up their twigs, in the process of depositing, and although their injury in the forest is not generally felt, it is a very different thing in our orchards, and especially in the nursery.

The following editorial from the old *Valley Farmer* of November, 1855, will show how serious the injury may sometimes be:

"We planted an orchard of the best varieties of apple trees last spring. We had taken particular pains, not only in selecting the best varieties, but in planting the trees, and hoped in a few years to partake of the fruit. But our hopes were destined to be blasted. The locusts during the summer destroyed nearly all of them; not one in six is living. To look at them one would think that some person had been drawing the teeth of a saw over the bark of every tree."

It also appears that in some instances they injure trees by the insertion of their beaks for nourishment, for Mr. Gustavus Pauls, of Eureka, had a young apricot tree which was so thoroughly punctured in this manner, that he took a gallon of coajulated sap from it, and he attributes the death of some of his trees to this cause. I am convinced, however, that the injury done in this manner is comparatively trifling.

On the 13th of June I was sent for by four different parties in St. Louis county, who wished me to try and save their trees from the ruinous work of these cicadas, which had by this time began to deposit their eggs in real earnest. I found that when the wind was high they could, by its aid, be driven to some extent, but that without its aid they could not be driven at all; as when started, they are just as likely to fly behind as before you. I tried lye, whitewash and sulphur, air-slacked lime and finally carbolic acid, and found that none of these mixtures would affect them. Indeed, after experiments involving about $200, I am convinced that there is no available way of entirely preventing this ruinous work when they once commence to deposit. The nursery of Mr. Stephen Partridge, a few miles west of St. Louis, which is surrounded on all sides by timber, was more seriously injured than any other which I saw, and he lost many hundred dollars' worth of apple, peach and pear stock. They also punctured his grape vines very freely, preferring the Clinton and Taylor among varieties. By having all hands turn out early in the morning, and between six and seven o'clock in the evening, while they hung listlessly to the branches, he succeeded in crushing thousands of them, and thus saved parts of his nursery from total ruin. But it becomes a hopeless task to try to stay their disastrous work when once they have acquired full power of flight; though, while in their feeble and helpless condition, as they leave the ground, they can not only be destroyed to far greater advantage by human agency, but hogs and poultry of all kinds, eagerly devour them. There were, it is true, many accounts afloat last summer of hogs being poisoned by them, and, though it is not impossible that one was occasionally killed by over-glutting,* such cases were very rare indeed. From the foregoing, the importance of knowing beforehand when to expect them becomes apparent, and the following chronological table, will not only prove of great scientific interest but of practical value. In the greater part of Missouri, the fruit grower may rest from all anxiety as to their appearance for thirteen years to come, but in the month of May, 1881, let him look out for them.

THEIR CHRONOLOGICAL HISTORY, WITH PREDICTIONS OF THE FUTURE APPEARANCE OF ALL WELL ASCERTAINED BROODS THROUGHOUT THE COUNTRY.

As nothing had been published up to A. D. 1868, as to the regular appearance of any thirteen year broods of Cicadas, it is not at

* Mr. F. R. Allen, of Allenton, informs me that during years when the army worm (*Leucania unipunctata*, Haw.) occurred in such swarms, hogs and chickens feasted on them to such an extent that the former frequently died, while the latter laid eggs in which the parts naturally white would be entirely green when cooked.

all surprising that errors were committed by former writers on the subject. In the following chronology of this insects periodical visits, everything heretofore published has been revised as far as possible. The mass of facts from which the generalizations are made would be tedious if given in detail, and are therefore for the most part omitted. This chronology could not, of course, be made complete from a single season's researches, and it may even contain errors, but it will remain as a foundation for future work, and before another seventeen years shall have passed away, we may hope to have this part of the history of our curious Cicadas completed and perfected.

While the discovery of the thirteen year broods, dispelled much of the fog in which this chronology had hitherto been wrapped, it at the same time, rendered a complete and lucid exposition of that chronology extremely difficult. The northern boundary line of the thirteen year broods is about latitude 37°, but in Illinois one of them ascends between two and three degrees above this line, while the seventeen year broods descend below it in several places, the two broods sometimes occupying the Carolina. Thus the two broods sometimes occupy the same territory; while two broods of the same kind, appearing in different years may also overlap one another, as in the instance given in the account of brood XXII in Virginia, where the "locusts" appear every eighth and ninth year. In order to make the subject as clear as possible, and to facilitate references, I have numbered the different broods of this insect in accordance with the date of their future appearance from and after the present year.

BROOD I.—*Septemdecim*—1852, 1869.

In the year 1869, and at intervals of seventeen years thereafter, they will, in all probability, appear in the valley of the Connecticut river. According to Dr. Asa Fitch (N. Y. Rep. I, p. 40), they appeared there in 1818 and 1835, and according to Dr. Smith they occurred in Franklin, Bristol and Hampshire counties, Massachusetts, in 1767, '84, 1801, '18, '35 and '52.

BROOD II.—*Tredecim*—1856, 1869.

In the year 1869, being the same as the preceding, they will in all probability appear in Georgia, in Habersham, Rabun? Muscogee, Jasper, Greene, Washington and adjacent counties, having appeared there in 1843 and 1856, according to Dr. Smith.

BROOD III.—*Septemdecim*—1853, 1870.

In the year 1870, and at intervals of seventeen years thereafter, they will in all probability appear in what is known as the "Kreitz Creek Valley" in York county, Pa., and possibly in Vinton county, Ohio, and Jo. Daviess county, Ills. Mr. S. S. Rathvon, of Lancaster, Pa., speaking of this brood, says: "Lancaster county is bounded on the southwest by the Susquehanna river, dividing it from the county of York, along the northeastern margin of which there is a mountain range, sloping down to the river. Along that slope Cicadas were abundant the present season (1868—Brood XXII). But on the southwest side of the range, in what is known as the Kreitz Creek Valley, there were none. They appeared last in this valley in 1853, and previous to that year at intervals of seventeen years from time immemorial." Dr. Smith records their appearance in 1853, both in Vinton county, Ohio, and Jo. Daviess county, Illinois.

BROOD IV.—*Tredecim*—1857, 1870.

In the year 1870, being the same as the preceding, they will in all probability appear in Jackson, Gadsden and Washington counties, Florida, having appeared there according to Dr. Smith in 1844 and 57.

BROOD V.—*Septemdecim*—1854, 1871.

In the year 1871, and at intervals of 17 years thereafter, they will in all probability appear around the head of Lake Michigan, extending as far east as the middle of the State of Michigan, and west an unknown distance into Iowa. Also in Walworth county and other portions of Southern Wisconsin, and southward into Illinois. This brood is equal to Dr. Fitch's 6th. It extends all over Northern Illinois, and as far south as Edgar county, and its appearance in 1837 and 1854 is well and thoroughly recorded. In Champaign county, Ills., it overlaps Brood XVIII, or the Southern Illinois *tredecim* brood, while it also interlocks with Brood XIII (*septemdecim*) in the same county.

They will also appear in the same years in the southeast by eastern part of Lancaster county, Pa., in what is called the "Pequea Valley," having appeared there in vast numbers in 1854.

The earliest known record we have of the appearance of periodcal Cicadas, is in Morton's "Memorial," in which it is stated that they appeared at Plymouth, Plymouth county, Mass., in the year 1633.—Now, according to that date, one might be led to suppose that this recorded brood of Morton's belonged to this Brood III, as exactly 14 periods of 17 years will have elapsed between 1633 and 1871; but, strange to say, we have no other records of his brood than that in the "Memorial," whereas there are abundant records of their appearing one year later in the same locality, ever since 1787. There is therefore good reason to believe that the visit recorded by Morton was a premature one, and that it was properly due in 1634. I have therefore placed it in Brood XIII, and have little doubt but that if records could be found, these would prove the Cicadas to have appeared in 1651, 1668, 1685, 1702, 1719, 1736, 1753, and 1770, as they did in 1787, 1804, 1821, 1838, and 1855.

BROOD VI.—*Tredecim*—1858, 1871.

In the year 1871, being the same year as the preceding, and at intervals of 13 years thereafter, they will in all probability appear in the extreme southwestern corner of Mississippi, and in the adjoining part of Louisiana. Dr. D. L. Phares of Newtonia (near Woodville), Miss., says that in 1858 they extended over most of Wilkinson and part of Amite counties, Mississippi, and East and West Feliciana, La. He has himself witnessed the appearance of this brood during the years 1832, 1845 and 1858, while it is distinctly remembered by aged people in his neighborhood as having also appeared there in the years 1806 and 1819. Dr. Smith gives their range from the Mississippi river, east to a ridge 45 miles from the river that divides the State, north and south, and north and south to the boundaries of the State; recording them as occurring in 1806, '19, '32, '45 and '58.

BROOD VII.—*Tredecim*—1859, 1872.

In the year 1872, and at intervals of 13 years thereafter, they will in all probability appear in Jackson county and around Cobden and Jonesboro, in Union county, South Illinois, in Kansas, Missouri, Georgia, Louisiana, Tennessee and Mississippi.

According to Mr. Paul Frick of Jonesboro, they were in Union county, Ills., in 1858, and he also thinks it was a great year for them *about* 1832. Those of 1858 were probably premature stragglers of the 1859 brood, while Mr. Frick is most likely mistaken as to the year 1832, since the Rev. George W. Ferrell of Cobden, Union county, witnessed their appearance at that place in 1833, and also in 1846 and 1859; and Cyrus Thomas has also recorded their appearance in 1859 in the 5th Rep. of the Ills. State Agr. Soc., p. 458*, while a paragraph in the Baltimore (Md.) *Sun* of June 13, 1859 says "the locusts have made their appearance in 'Egypt' in Southern Illinois, and cover woods and orchards in swarms." This brood not improbably extends westward into Missouri, for several of the old settlers around Eureka, in St. Louis county, Mo., recollect it being "locust year" about the time of its last appearance, while Mr. L. D. Votaw of Eureka, and Wm. Muir of Fox Creek, Mo., both believe it was exactly 9 years ago, or in the year 1859. Dr. Smith records it in DeKalb, Gwinnett and Newton counties, Georgia, in 1846 and '59; in the northern part of Tennessee also, in 1846 and '59; in the whole eastern portion of Mississippi from the ridge which is 45 miles from the river, on the west, to the eastern boundary, in 1820, '33, '46, and '59; in Carrol Parish, Louisiana, in 1859; and in Philips county, Kansas, in the same year.

By referring to Brood XV, it will be seen that in 1846, or during the first year of the Mexican war, this 13-year brood appeared simultaneously with a 17-year brood in western Pennsylvania and Ohio.

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* If Mr. Paul Frick is correct, the brood he has witnessed may possibly be a detachment of the Mississippi and Louisiana Brood VI; in which case the Cicadas appear for two consecutive years in Union county, Ills., as they do (See Broods XIII and XIV) in Central Ohio, and portions of Northwestern Missouri.

BROOD VIII.—*Septemdecim*—1855, 1872.

In the year 1872, being the same year as the preceding, and at intervals of 17 years thereafter, they will, in all probability, appear in the southeastern part of Massachusetts; across Long Island; along the Atlantic coast to Chesapeake Bay, and up the Susquehanna at least as far as to Carlisle in Pennsylvania; also, in Kentucky, at Kanawha in Virginia, and Gallipolis, Ohio, on the Ohio river. This is the brood referred to in Brood V, and which there is every reason to believe is the one recorded by Morton in his "Memorial," as occurring in 1633.

Dr. Fitch, in the account of his 3d brood (N. Y. Rep. I, p. 39), says: "The third brood appears to have the most extensive geographical range. From the southeastern part of Massachusetts, it extends across Long Island, and along the Atlantic coast to Chesapeake Bay, and up the Susquehanna at least as far as to Carlisle in Pennsylvania; and it probably reaches continuously west to the Ohio, for it occupies the valley of that river at Kanawha in Virginia, and onwards to its mouth, and down the valley of the Mississippi probably to its mouth, and up its tributaries, west, into the Indian Territory. This brood has appeared the present year, 1855, and I have received specimens from Long Island, from South Illinois, and the Creek Indian country west of Arkansas," etc.

There is every reason to believe that Dr. Fitch, in this account, has confounded this *septemdecim* Brood VIII, with the great *tredecim* Brood XVIII, for it so happened that they both occurred simultaneously in 1855, but the exact dividing line of these two broods is not so easily ascertained. Certainly, after reaching the Ohio river, the *septemdecim* brood extends beyond Gallipolis, Ohio, for Prof. Potter, in his "Notes on the Cicada decem septima," records their appearance at that place in 1821; and Dr. Smith records their appearance at Frankfort, Lexington and Flemingsburg, Kentucky, in 1838, and 1855. But I strongly incline to believe that well nigh the rest of the territory mentioned by Dr. Fitch was occupied by the *tredecim* brood, the reasons for which belief will be found in the account of brood XVIII.

Cicadas also appeared in Buncombe and McDowell counties, North Carolina, in 1855, but until they appear there again it will be impossible to say, positively, whether they belong to this *septemdecim* Brood VIII, or to the *tredecim* Brood XVIII.

BROOD IX—*Septemdecim*—1857, 1874.

In the year 1874, and at intervals of 17 years thereafter, they will propably occur in southeast Nebraska.

The occurrence of this brood was communicated to me by Mr. Clarke Irvine, of Oregon, Holt county. The brood is most likely confined to the eastern or timbered portion of the State, and I judge it to be *septemdecim*, from the fact that the latitude is rather more northerly than tredecim is known to occur.

BROOD X—*Tredecim*—1862, 1875.

In the year 1875, and at intervals of 13 years thereafter, they will most likely occur in different parts of Texas. According to Dr. Smith they appeared in vast numbers in some parts of Texas in 1849, though he was not able to get any particulars.

BROOD XI—*Septemdecim*—1859, 1876.

In the year 1876, and at intervals of 17 years thereafter, they will in all probability appear in parts of North Carolina, Virginia, Maryland, Illinois and Indiana. According to Dr. Smith they appeared from Raleigh, North Carolina, to near Petersburg, Virginia, in 1842 and 1859; in Rowan, Davie, Cabarras and Iredell counties in the same State in 1825, 1842 and 1859; in the valley of Virginia as far as the Blue Ridge on the east, the Potomac river on the north, the Tennessee and North Carolina lines on the south, and for several counties west, in 1808, 1842 and 1859; in the south part of St. Mary's county, Maryland, dividing the county about midway east and west, in 1825, 1842 and 1859; in Illinois about Alton in 1842 and 1859; and in Sullivan and Knox counties, Indiana, in 1842 and 1859.

BROOD XII—*Septemdecim*—1860, 1877.

In the year 1877, and at intervals of 17 years thereafter, they will, in all probability, appear in the vicinity of Schuylerville and Fort Miller, in New York. From thence along both sides of the Hudson to its mouth, where they extend, at least, to New Haven, in Connecticut, and west across the north part of New Jersey and into Pennsylvania. Also in Dearborn county, Indiana; Kalamazoo, Michigan; in Pennsylvania, North Carolina, Virginia and Maryland.

This brood is recorded by Prof. Potter as having occurred at North Haven, Conn., in 1724, 1741, 1758, 1792, 1809 and 1826. It was also recorded by the same writer as having occurred in 1826 in Middlesex county, N. J., and by Dr. Fitch as having occurred in 1843 throughout the whole country mentioned above. In 1860, again, it was spoken of in the old series of the *Prairie Farmer* (Vol. 22, p. 119) as having occurred that year in New Jersey, and Dr. Smith records it throughout the whole State in 1775, 1792, 1809, 1826 and 1843. Mr. Jas. Angus, of West Farms, Westchester county, N. Y., has himself witnessed its recurrence in the years 1843 and 1860.

In Pennsylvania, Mr. Rathvon found a few individuals in 1860, and Dr. Smith says it extends from the Susquehanna to the Delaware river, bounded by Peter's mountain on the south. In Virginia it occurred from the south part of Loudon county to the Roanoke river, and from the Blue Ridge to the Potomac in 1826, 1843 and 1860. In Maryland from Ann Arundel county to the north part of St. Mary's, and from the Potomac to Chesapeake Bay, in 1809, 1826, 1843 and 1860. In Rockingham, Stokes, Guilford, Rowan, Surrey and adjacent counties, North Carolina, in 1792, 1809, 1826 and 1843. In Dearborn county, Indiana, in 1843 and in 1860, and in Kalamazoo, Michigan, during the same years.

BROOD XIII.—*Septemdecim*—1861, 1878.

In the year 1878, and at intervals of 17 years thereafter, they will, in all probability, appear along the centre of the State of Illinois, all along the southern part of Iowa, and around St. Joseph, in Buchanan county, in North Missouri.

The records are abundant, of their appearance, in 1844 and 1861, all along the southern border of Iowa, and in Mason, Fulton, McDonough and Champaign counties in Central Illinois. In 1861 they also occurred in Champaign county, Central Ohio, and in Buchanan county, Northwest Missouri; and this brood not unlikely occupies, more or less, the whole strip of country between these two points. Their appearance in 1861 was associated with the first year of the rebellion; and Dr. Smith records this brood both in Illinois and Iowa in 1844.

BROOD XIV.—*Septemdecim*—1862, 1879.

In the year 1879, and at intervals of 17 years thereafter, they will, in all probability, appear in the whole of western Missouri, commencing south about Johnson and Saline counties, and extending in a northwesterly direction to Lawrence and above, in Kansas, south to Arkansas, and west an unknown distance into Kansas; also, in Central Ohio.

The occurrence of this brood in 1845 and 1862 is well remembered by several of my correspondents, and is recorded by Dr. Smith. At St. Joseph, in Buchanan county, Mo., Cicadas were not so thick in 1862 as in 1861. Had it been the reverse, or, in other words, had they been more numerous in 1862 than in 1861, I should have been inclined to record the visit of 1861 as but a precursor to this Brood X; but as it is, I believe the two broods are distinct, and that they occur for two consecutive years, both in Central Ohio and in portions of Northwest Missouri.

This brood has not been traced further east, in Missouri, than Saline county, and yet a detachment of it certainly occurs in Ohio, for Mr. Clarke Irvine, of Oregon, Holt county, Mo., well remembers their occurrence in Central Ohio in 1845 and 1862. Though there is no knowledge of the appearance of this Brood XIV in Illinois, yet the fact of its occurring both in Ohio and in North Missouri, and that, too, but one year after Brood XIII, would indicate that there may have been, in times past, at all events, if there is not at the present day, a geographical connection between these two broods.

BROOD XV.—*Septemdecim*—1863, 1880.

In the year 1880, and at intervals of 17 years thereafter, they will, in all probability, appear from western Pennsylvania to Sciota river, east, and down the valley of the Ohio river as far as Lewis county, in Virginia.

This brood is recorded in Ohio as far back as the year 1812, by "A. M. B.," writing to the Chicago *Tribune*, under date of June 22, 1868. Harris also records its appearance in Ohio in 1829, and they were quite numerous in Coles county, in the centre of the same State in 1846, or during the first year of the Mexican war, while Dr. Smith records it in the eastern part of the State, extending over twelve counties, west, to the Sciota river, and to Sandusky, on Lake Erie, in 1829, '46 and '63; and in Lewis county, Virginia, since 1795. As before stated this brood occurred in Ohio in 1846, simultaneously with the *tredecim* brood VII in South Illinois. Dr. Fitch, in his account of his 5th brood, also records its appearance, and states that it reached to Louisiana. But just as the *septemdecim* Brood VIII was confounded with the great *tredecim* Brood XVIII in 1855, so this *septemdecim* Brood XV was doubtless also confounded with it in 1829, for they both occurred that year. Had the western country been as thickly settled in 1829 as it was in 1855, the *tredecim* Brood XVIII could undoubtedly have been traced in Southern Illinois and Missouri, etc., in the former as it was in the latter year. This belief is furthermore greatly strengthened from our having no other record of the appearance of this *septemdecim* brood, in Louisiana, than Prof. Potter's statement that they appeared there in 1829, whereas they have occurred there since 1829 at intervals, not of 17, but of 13 years, and were there the present year, 1868, as will be seen on referring to Brood XVIII. The dividing line of these two broods (XV and XVIII) is probably the same as with broods VIII and XVIII.

BROOD XVI.—*Tredecim*—1867, 1880.

In the year 1880, being the same as the preceding, they will, in all probability, appear in the north part of Cherokee county, Georgia, having appeared there according to Dr. Smith in 1828, '41, '54, and according to Dr. Morris, in 1867. This brood occurred in 1867 simultaneously with the northern *septemdecim* brood XXI.

BROOD XVII.—*Septemdecim*—1864, 1881.

In 1881, and at intervals of 17 years thereafter, they will, in all probability, appear in Marquette and Green Lake counties, in Wisconsin, and may also appear in the western part of North Carolina, and about Wheeling, Virginia; in Northeast Ohio, and a few in Lancaster county, Pa., and Westchester county, New York.

There is abundant evidence that they appeared in the counties named in Wisconsin in 1864, and fair evidence that they appeared that year in Summit county, Northeast Ohio, while straggling specimens were found in the same year, by Mr. S. S. Rathvon, in Lancaster county, Pa., and by Mr. James Angus, in Westchester county, N. Y. Dr. Fitch also records their appearance in 1847, or 17 years previously, in the western part of North Carolina, and Dr. Smith, in Wheeling, Virginia, in 1830, '47 and '64. The distance between the localities given is very great, and it is doubtful whether all these records belong to one and the same brood.

BROOD XVIII.—*Tredeim*—1868, 1881.

In the year 1881, and at intervals of 13 years thereafter, they will, in all probability, appear in Southern Illinois, throughout Missouri, with the exception of the northwestern corner, in Louisiana, Arkansas, Indian Territory, Kentucky, Tennessee, Mississippi, Alabama, Georgia, and North and South Carolinas.

Though, as already stated, I published the first account ever given of the existence of a 13–year brood, yet, besides the others mentioned in this chronology, this particular brood has been traced since, as having occurred in the years 1816, '29, '42, '55 and '68; and Mr. L. W. Lyon, at the July (1868) meeting of the Alton, (Ills.) Horticultural Society, even mentioned its appearance in 1803.

In Missouri, it occurs more or less throughout the whole State with the exception of the northwest corner that is bounded on the east by Grand river, and on the south by the Missouri river.* The southeast part of the State, where Dr. Smith has recorded it since 1829, is most thickly occupied. I enumerate those counties in which there is undoubted evidence of their appearance during the present year (1868) viz.: Audrain, Bollinger, Benton, Clarke, Chariton, Callaway, Cooper, Cole, Franklin, Gasconade, Iron, Jefferson, Knox, Lewis, Marion, Macon, Morgan, Moniteau, Pike, Phelps, Pulaski, Polk, Pettis, Schuyler, St. Charles, St. Louis, St. Francois, St. Clair, Warren, and Washington.

It not improbably overlaps some of the territory occupied by the *septemdecim* Brood XIV, but I do not think it extends into Kansas.

In Illinois it occurs more or less throughout the whole southern half of the State, but more especially occupies the counties from the south part of Adams county along the Mississippi to the Ohio, up the Ohio and Wabash rivers to Edgar county, and then across the centre of the State, leaving some of the central counties in South Illinois unoccupied. To be more explicit, I enumerate all the counties in which it undoubtedly occurred during the present year (1868): Adams (south part, back of Quincy), Bond, Clinton (northwest corner, adjacent to Madison), Champaign, Coles, Crawford, Cumberland, Clay, Clark, Edwards, Edgar† (especially in the eastern part), Franklin, Gallatin, Hardin, Hamilton, Johnson, Jasper, Jersey, Jefferson, Lawrence, McLean (east end), Macon, Madison, Marion, Massac, Monroe,

*As Mr. Wm. Raucher, of Oregon, Holt county, saw a few individuals in the northeast part of Buchanan county in 1855, it may occur in small numbers in districts even north of the Missouri river.

† Edgar county also has the *septemdecim* Brood III.

Pike, Perry, Piatt, Pope, Richland, Randolph, Sangamon, Saline, St. Clair, Union (northeast corner), Washington, Wayne, Wabash, Williamson and White. There were none the present year, either at Decatur, in Macon county, or at Pana in Christian county; nor were there any at Bloomington or Normal, in McLean; nor in Dewitt county, which lies south of McLean; nor in Spring Creek, Iroquois county, which is northeast of Champaign.

In Kentucky, according to Dr. Smith, it occurred in the northwest corner of the State, about Paducah and adjacent counties south, in 1829, '42, and '55, and it occurred there in 1868.

In Arkansas, it occupied all the northern counties in 1842, '55 and '68.

In Alabama, it occupied Russell and adjacent counties on the east side of Black Warrior river, in 1842, '55 and '68.

In Tennessee, it occupied Davidson, Montgomery, Bedford, Williamson, Rutherford and adjacent counties in 1842, '55* and '68.

In North Carolina, it appeared in Mecklenburg county, in 1829, '42, '55 and '68.

In South Carolina, the Chester district and all the adjoining country to the Georgia line, west, and to the North Carolina line, north, was occupied with it in 1816, '29, '42, '55 and '68.

In Georgia, it has occurred in Cherokee county since the year 1816.

In Louisiana, it appeared in Morehouse, Caddo, Clairborne, Washington and adjacent parishes, in 1855 and '68.

It also doubtless occurs in Mississippi and Indian Territory, though I am unable to specify any localities.

BROOD XIX.—*Septemdecim*—1865, 1882.

In the year 1882, and at intervals of 17 years thereafter, they will, in all probability, appear in Monroe, Livingston, Madison and adjacent counties, and around Cayuga Lake, in New York.

Mr. T. T. Southwick, of Manlius, Livingston county, records their appearance there in 1865, and, as will be seen by referring to the *Prairie Farmer*, vol. 16, p. 2, they appeared during the same year near Cayuga Lake, while Dr. Smith records their appearance in 1797, 1814, '31 and 48.

BROOD XX.—*Septemdecim*—1866, 1883.

In the year 1883, and at intervals of 17 years thereafter, they will, in all probability, appear in western New York, western Pennsylvania and eastern Ohio. In the last mentioned State they occur more especially in Mahoning, Carroll, Trumbull, Columbiana and adjacent counties, overlapping, especially in Columbiana county, some of the

* Though they occurred in large numbers in Davidson county and other portions of Tennessee in 1855, and also the present year, yet in Lawrence county they appeared in 1856, instead of 1855—another instance of a belated brood.

territory occupied by Brood XV. In Pennsylvania, they occupy nearly all the western counties, and their appearance is recorded in 1832, '49 and '66, by Dr. Fitch (his second brood), Dr. Smith, and several of my correspondents; the following counties being enumerated: Armstrong, Clarion, Jefferson, Chemung, Huntingdon, Cambria, Indiana, Butler, Mercer and Beaver.

BROOD XXI.—*Septemdecim*—1867, 1884.

In the year 1884, and at intervals of 17 years thereafter, they will, in all probability, appear in certain parts of North Carolina and Central Virginia. In 1850 and 1867 they appeared near Wilkesboro N. C., and were also in Central Virginia during the last mentioned year, while Dr. Smith mentions them as occurring in Monroe county, and the adjacent territory, in Virginia in 1833 and 1850.

Dr. Harris (Inj. Insects, p. 210) records their appearance at Martha's Vineyard, Massachusetts, in 1833, but as I cannot learn that they were there, either in 1850 or 1867, I infer that Dr. Harris's informant was mistaken.

BROOD XXII.—*Septemdecim*—1868, 1885.

In the year 1885, and at intervals of 17 years thereafter, they will, in all probability, appear on Long Island; at Brooklyn, in Kings county, and at Rochester in Monroe county, New York; at Fall River, and in the southeastern portion of Massachusetts; at Oakland (Rutland?), Vermont; in Pennsylvania, Maryland, District of Columbia, Delaware and Virginia; in northwestern Ohio, in southeastern Michigan, in Indiana and Kentucky.

This brood has been well recorded in the East in 1715, 1732, 1749, 1766, 1783, 1800, 1817, 1834, 1851 and 1868. It is spoken of in "Hazzard's Register" for 1834, published in Philadelphia, while Mr. Rathvon has himself witnessed its occurrence during the four latter years in Lancaster county, Pa.

It is the fourth brood of Dr. Fitch, who only says that it "reaches from Pennsylvania and Maryland to South Carolina and Georgia, and what appears to be a detached branch of it occurs in the southeastern part of Massachusetts." He is evidently wrong as to its occurring in South Carolina and Georgia, and it is strange that he does not mention its appearance in New York, for Mr. F. W. Collins, of Rochester, in that State, has witnessed four returns of it there, namely: in 1817, '34, '51 and '68, while the Brooklyn papers record its appearance there the present season. As these two points in the State are about as far apart as they well can be, the intervening country is probably more or less occupied with this brood. Mr. H. Rutherford, of Oakland,* Vermont, records their appearance in that neighborhood in 1851 and 1868.

*I can find no such post office as Oakland in Vermont, and incline to believe that the *Tribune* compositor made Oakland out of Rutland, and more especially as Rutland is on the New York border.

(N. Y. Semi-Weekly *Tribune*, June 27). He also witnessed them in the same place in 1855, and as will be seen by referring to Brood XVIII, they also occurred on Long Island and in southeastern Massachusetts in that same year, 1855. Exactly 13 years intervening between 1855 and 1868, one might be led to suppose that they had a *tredecim* brood in the East. But did such a brood exist, it would certainly have been discovered ere this, in such old settled parts of the country, and all the records go to show that they have nothing but *septemdecim* there. By referring to Brood VIII, the mystery is readily solved, for we find that in that part of the country there are two *septemdecim* broods—the one having last appeared in 1855—the other the present year, 1868.

In Ohio, this brood occurred more or less throughout the whole western portion of the State, for our correspondents record them as having appeared in 1868 in Lucas and Hamilton and several intervening counties. Mr. F. C. Hill, of Yellow Springs, in Green county, Southwest Ohio, has witnessed their appearance in 1834, 1851 and 1868, and they occurred in the northwestern part of the State during the three same years; while the correspondent to the Department of Agriculture, from Toledo, Northwest Ohio (July, 1868, Monthly Rep.), says it is their 9th recorded visit there. Dr. Smith records it as occurring around Cincinnati, in Franklin, Columbiana, Pike and Miami counties.

In Indiana, there is reliable evidence of their appearance, in 1868, in the southern part of the State, in Tippecanoe, Delaware, Vigo, Switzerland, Hendricks, Marion, Dearborn, Wayne, Floyd, Jefferson and Richmond counties. The evidence seems to show that, as in Ohio, throughout the State, they belong to this *septemdecim* Brood XXII, for Mr. F. Guy, of Sulphur Springs, Mo., has personally informed me that they were in Southern Indiana in 1851, and even in Tippecanoe county, on the Wabash river, where, from their proximity to Brood XVIII, one might have inferred them to be *tredecim*, they are recorded as appearing in 1834 and '51.

In Kentucky they appeared around Louisville. In Pennsylvania, Maryland, Delaware and Virginia, the territory occupied by this brood is thus described by Dr. Smith: "Beginning at Germantown, Pa., to the middle of Delaware; west through the east shore of Maryland to the upper part of Ann Arundel county; thence through the District of Columbia to Loudon, West Virginia, where it ☞ laps over the South Virginia district (see Brood XII) from the Potomac to Loudon county, some 10 or 12 miles in width, and in this strip of territory Cicadas appear every 8th and 9th year. Thence the line extends through the north counties of Virginia and Maryland to the Savage mountains, and thence along the south tier of counties in Pennsylvania, to Germantown."

From the above synoptical view it results that there will, during the next 17 years, be broods of the Periodical Cicada somewhere or other in the United States in A. D. 1869, '70, '71, '72, '74, '75, '76, '77, '78, '79, '80, '81, '82, '83, '84 and '85—or every year but 1873. It further appears that the number of distinct broods, appearing in distinct years, within the following geographical districts, are as follows: In southern New England 4 broods, years '69, '72, '77 and '85; in New York 5 broods, years '72, '77, '82, '83 and '85; in New Jersey 2 broods, years '72 and '77; in Pennsylvania 7 broods, years '70, '71, '72, '77, '80, '83 and 85; in Ohio 7 broods, years '72, '78, '79, '80, 81, '83 and '85; in Indiana 4 broods, years '71, '76, '77 and '85; in Illinois 6 broods, years '71, '72*, '76, '77, '78 and '81*, and probably another in Jo Daviess county, year '70; in Wisconsin 2 broods, years '71 and '82; in Michigan 2 broods, years '71 and '85; in Iowa 2 broods, years '71 and '78; in Nebraska 1 brood, year '74; in Kansas 2 broods, years '72* and '79; in Missouri 4 broods, years '72*, 78, '79 and '81*; in Louisiana and Mississippi 3 broods, years '71*, '72* and 81*; in Tennessee 2 broods, years '72* and '81*; in Arkansas, Indian Territory and Alabama, 1 brood, year '81*; in Kentucky 3 broods, years '72, '81* and 85; in Georgia 4 broods, years '69*, '72*, '80* and '81*; in South Carolina 1 brood, year '81*; in North Carolina 6 broods, years '72?, '76, '77, '81?, '81* and '84; in East and West Virginia 5 broods, years '72, '77, '80, '81 and 84; in Maryland 4 broods, years '72, '76, 77 and 85; in District of Columbia 1 brood, year '85; in Delaware 2 broods, years '72 and 85; in Florida 1 brood, year 73*; in Texas 1 brood, year 75*.

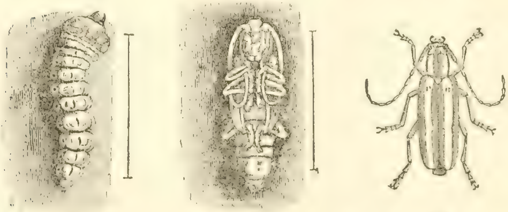
* The broods marked (*) belong to the 13-year or tredecim race of the Periodical Cicada.

APPLE-TREE BORERS.

(Coleoptera, Cerambicidæ.)

THE ROUND-HEADED APPLE-TREE BORER—*Saperda bivittata*, Say.

[Fig. 14.]



a *b* *c*

It is a fact which has not been disputed by any one whom I have queried on the subject, that apple trees on our ridges are shorter lived than those grown on our lower lands. Hitherto no particular reason has been given for this occurrence, but I think it is mainly attributable to the workings of the borer now under consideration. I have invariably found it more plentiful in trees growing on high land than in those growing on low land, and it has also been my experience that it is worse in ploughed orchards than in those which are seeded down to grass. Fifty years ago, large, thrifty, long-lived trees were exceedingly common, and were obtained with comparatively little effort on the part of our ancestors. They had not the vast army of insect enemies to contend with, which at the present day make successful fruit-growing a scientific pursuit. This Apple-tree borer was entirely unknown until Thomas Say described it in the year 1824; and, according to Dr. Fitch, it was not till the year following that its destructive character became known in the vicinity of Albany, N. Y., for the first time. Yet it is a native American insect, and has for ages inhabited our indigenous crabs, from which trees my friend, Mr. A. Bolter, took numerous specimens, in the vicinity of Chicago, ten years ago. It also attacks the quince, mountain ash, hawthorn, pear and the June-berry. Few persons are aware to what an alarming extent this insect is infesting the orchards in St. Louis, Jefferson and adjacent counties, and, for aught I know, throughout the State. A tree becomes unhealthy and eventually dwindles and dies, often without the owner having the least suspicion of the true cause—the gnawing worm within. Even in the orchard of the most worthy president of our State Horticultural Society, I found one or more large worms at the base of almost every tree that I examined, notwithstanding he had been of the opinion that there was not a borer of this kind on his place.

At Figure 14, this borer is represented in its three stages of larva (*a*), pupa (*b*), and perfect beetle (*c*). The beetle may be known by the popular name of the Two-striped Saperda, while its larva is best known by the name of the Round-headed apple-tree borer, in contradistinction to the Flat-headed species, which will be presently treated of.

The average length of the larva, when full-grown, is about one inch, and the width of the first segment is not quite $\frac{1}{4}$ of an inch. Its color is light yellow, with a tawny yellow spot of a more horny consistency on the first segment, which, under a lens, is found to be formed of a mass of light brown spots. The head is chestnut-brown, polished and horny, and the jaws are deep black. The pupa is of rather lighter color than the larva, and has transverse rows of minute teeth on the back, and a few at the extremity of the body; and the perfect beetle has two longitudinal white stripes between three of a light cinnamon-brown color. The Two-striped Saperda makes its appearance in the beetle state during the months of May and June, and is seldom seen by any but the entomologist who makes a point of hunting for it—from the fact that it remains quietly hidden by day and flies and moves only by night. The female deposits her eggs during the month of June, mostly at the foot of the tree, and the young worms hatch and commence boring into the bark within a fortnight afterwards. These young worms differ in no essential from the full grown specimens, except in their very minute size; and they invariably live, for the first year of their lives, on the sap-wood and inner bark, excavating shallow, flat cavities which are found stuffed full of their sawdust-like castings. The hole by which the newly hatched worm penetrated is so very minute that it frequently fills up, though not till a few grains of castings have fallen from it; but the presence of the worms may be generally detected, especially in young trees, from the bark, under which they lie, becoming darkened, and sufficiently dry and dead to contract and form cracks. Through these cracks, some of the castings of the worm generally protrude, and fall to the ground in a little heap, and this occurs more especially in the spring of the year, when, with the rising sap and frequent rains, such castings become swollen and augment in bulk. Some authors have supposed that the worm makes these holes to push out its own excrement, and that it is forced to do this to make room for itself; but, though it may sometimes gnaw a hole for this purpose, such an instance has never come to my knowledge, and that it is necessary to the life of the worm is simply a delusion, for there are hundreds of boring insects which never have recourse to such a procedure, and this one is frequently found below the ground, where it cannot possibly thus get rid of its castings. It is currently supposed that this borer penetrates into the heart wood of the tree after the first year of its existence, whereas the Flat-headed species is supposed to remain for the most part immediately under the bark; but I find that on these points no rules can be given, for the Flat-headed species also frequently penetrates into the solid heart wood, while the species under consideration is frequently found in a full grown state just under the inner bark, or in the sap-wood. The usual course of its life, however, runs as follows:

As winter approaches, the young borer descends as near the ground as its burrow will allow, and doubtless remain inactive till the following spring. On approach of the second winter it is about one-half grown and still living on the sap-wood; and it is at this time that these borers do the most damage, for where there are 4 or 5 in a single tree, they almost completely girdle it. In the course of the next summer when it has become about three-fourths grown, it generally commences to cut a cylindrical passage upward into the solid wood, and before having finished its larval growth, it invariably extends this passage right to the bark, sometimes cutting entirely through a tree to the opposite side from which it commenced; sometime turning back at different angles. It then stuffs the upper end of the passage with sawdust-like powder, and the lower part with curly fibres of wood, after which it rests from its labors. It thus finishes its gnawing work during the commencement of the 3d winter, but remains motionless in the larval state till the following spring when it casts off its skin once more and becomes a pupa. After resting three weeks in the pupa state it becomes a beetle, with all it members and parts at first soft and weak. These gradually harden and in a fortnight more it cuts its way through its sawdust-like castings, and issues from the tree through a perfectly smooth and round hole. Thus it is in the tree a few days less than three years, and not merely two years as Dr. Fitch suggests. I have come to this conclusion from having frequently found, during the past summer, worms of three distinct sizes in the same orchard, and Mr. D. B. Wier of Lacon, Ills., had previously published the fact*, while a correspondent to the *Country Gentleman* of Albany, N. Y.† who says he has large experience with this borer, sent to the editors specimens of all three sizes, which he calls "this years, two and three year old worms." The individual from which I drew my figures, and which was taken from a crab apple tree, went into the pupa state on the 14th day of March and became a beetle on the 15th of April; but was doubtless forced into rapid development by being kept throughout the winter in a warm room.

Remedies.—From this brief sketch of our Round-headed borer, it becomes apparent that plugging the hole to keep him in, is on a par with locking the stable door to keep the horse in, after he is stolen; even supposing there were any philosophy in the plugging system, which there is not. The round smooth holes are an infalliable indication that the borer has left, while the plugging up of any other holes or cracks where the castings are seen, will not affect the intruder. This insect probably has some natural enemies belonging to its own great class, and some of our wood-peckers doubtless seek it out from its retreat and devour it; but its enemies are certainly not sufficiently under our control, and to grow healthy apple trees, we have to fight it artificially. Here again prevention will be found better than cure, and a stitch in time will not only save nine, but fully ninety-nine.

Experiments have amply proved that alkaline washes are repulsive to this insect, and the female beetle will not lay her eggs on trees protected by such washes. Keep the base of every tree in the orchard free from weeds and trash, and apply soap to them during the month of May, and they will not likely be troubled with borers. For this purpose soft soap or common bar soap can be used. The last is perhaps the most convenient and the newer and softer it is, the better. This borer confines himself almost entirely to the butt of the tree, though very rarely it is found in the crotch. It is therefore only necessary in soaping, to rub over the lower part of the trunk and the crotch, but it is a very good plan to lay a chunk of the soap in the principal crotch, so that it may be washed down by the rains. In case these precautions have been unheeded, and the borer is already at work, many of them may be killed by cutting through the bark at the upper end of their burrows, and gradually pouring hot water into the cuts so that it will soak through the castings and penetrate to the in-

*_Prairie Farmer_, Chicago, April 20, 1867.

†_Country Gentleman_, Sept. 12, 1867.

sect. But even where the soap preventive is used in the month of May, it is always advisable to examine the trees in the fall, at which time the young worms that hatched through the summer may be generally detected and easily cut out without injury to the tree. Particular attention should also be paid to any tree that has been injured or sun-scalded, as such trees are most liable to be attacked. Mr. Wier who has had considerable experience with this insect, thus describes his method of doing this work, in the article already alluded to:

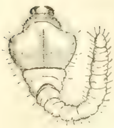
"I will suppose that I have a young orchard of any number of trees, say a thousand, the second season after planting, about the last of July, or during the first halt of August, with a common hoe, I take all the weeds and other trash, and about an inch of soil, from the crown of the trees; then, any time trom the first to the middle of September, with a pocket-knife, examine carefully the stem of each tree; the borer can readily be found by the refuse thrown out of the hole made on entering; this refuse of a borer, of the same season's growth, will be about the size of a pea, and, being of a glutinous nature, sticks around the mouth of the hole, and can rapidly be seen; older ones throw out coarser chips that fall to the ground. [As already shown these chips are not thrown out by the borer, but are forced out by swelling.] When one is found, take the knife and cut him out. If an orchard is carefully examined in this way each year, there need be but few, if any borers missed, and as they are more easily found the second fall of their growth, and can have done but little damage at that time, we would never receive any serious injury from them. Now, it is no great task to do this; a man will clear the litter and soil from around a thousand trees, in a day, and can take the borers out in another day. I will agree to do both jobs carefully in one day's time. A great undertaking is it not?"

He also has observed that some varieties of the apple-tree have a greater immunity from the attacks of this borer, than have others; on account of the young larva, when it is first hatched, being drowned out by the sap, but he does not mention any particular varieties other than those that are the "more vigorous and late growing."

THE FLAT-HEADED APPLE-TREE BORER—*Chrysobothr femorata*, Fabr.

(Coleoptera, Buprestidæ.)

[Fig. 15.]



[Fig. 16.]

This borer which is represented in the larva state at Figure 15, may at once be recognized by its anterior end being enormously enlarged and flattened. It is paler than the preceding, and makes an entirely different burrow. In consequence of its immensely broad and flattened head, it bores a hole of an oval shape and twice as wide as high. It never acquires much more than half the size of the other species, and is alm st always found with its tail curled completely round towards the head. It lives but one year in the tree and produces the beetle, represented at Figure 16, which is of a greenish black color with brassy lines and spots above, the underside appearing like burnished copper. This beetle flies by day instead of by night, and may often be found on different trees basking in the sunshine. It attacks not only the apple, but the soft maple, oak, peach, and is said to attack a variety of other forest trees; though, since the larvæ of the family (BUPRESTIDÆ) to which it belongs all bear a striking resemblance to each other, it is possible that this particular species has been accused of more than it deserves.

It is, however, but far too common in the Valley of the Mississippi, and along the Iron Mountain and Pacific railroads, it is even more common than the preceding species. Mr. G. Pauls, of Eureka. informs me that it has killed fifty apple trees for him, and Mr. Votaw, and many others in that neighborhood have suffered from it in like manner. It is also seriously affecting our soft maples by riddling them through and through, though it confines itself far the most part to the inner bark, causing peculiar black scars and holes in the trunk. Unless its destructive work is soon checked, it bids fair to impair the value of this tree for shade and ornamental parposes, as effectually as the Locust borers have done with the locust trees.

REMEDIES.—Dr. Fitch found that this borer was attacked by the larvæ of some parasitic fly, belonging probably to the *Chalcis* family, but it is greatly to be feared that this parasite is as yet unknown in the west. At all events this flat-headed fellow is far more common with us than with our eastern brethren. As this beetle makes its appearance during the months of May and June, and as the eggs are deposited on the trunk of the tree, as with the preceding species, the same method of cutting them out or scalding them can be applied in the one case as in the other; while the soap preventive is found to be equally effectual with this species as with the other. It must, however, be applied more generally over the tree, as they attack all parts of the trunk, and even the larger limbs.

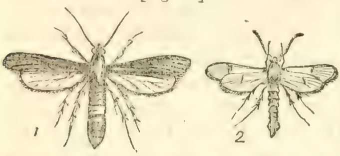
THE PEACH BORER—*Ægeria exitiosa*, Say.

(Lepidoptera, Ægeridæ.)

This pernicious borer I find to be quite common throughout the State. It is withal an insect so familiar to the peach-grower, and its history has been so often given in current entomological works that I should let it go unnoticed, were it not for the numerous letters of inquiry about it that have been sent to me during the year. For a complete and lengthened history of it, I refer the reader to the first of Dr. Fitch's most excellent reports.

From the Round-headed Apple-tree borer, to which it bears some resemblance both in its mode of work and general appearance, it is at once distinguished by having six scaly and ten fleshy legs. It works also more generally under the surface of the ground, and goes through its transformations within a year, though worms of two or three sizes may be found at almost any season. When full grown the worm spins for itself a follicle of silk, mixed with gum and excrement, and in due time issues as a moth. As it is not so well known in

[Fig. 17.]



this last state, I annex (Fig. 17) figures of both male (2) and female (1) moths. As will be seen from these figures, the two sexes differ very materially from each other, the general color in both being glossy steel-blue. Some specimens which were received from Mr. W. S. Jewett, of Pevely, Jefferson county, commenced issuing as moths on the 20th of July, but I found empty follicles the latter part of May in trees which had been thoroughly wormed the year before, and from which the moths has consequently left at that early date. This borer likewise attacks the plum-tree, though singularly enough it causes no exudation of gum in this as it does in the peach tree.

Remedies.—I have had ample occasion to witness the effects of the mounding system during the summer, in several different orchards, and am fully convinced that it is the best practical method of preventing the attacks of this insect, and that it matters little whether ashes or simple earth be used for the mound. True, there are parties who claim (and among them Dr. Hull, of Alton, Ills.,) that the almost complete exemption from borers in mounded peach-orchards is due, not to any special effect produced by the mound, but to the general rarity of the insect. But I have found no general rarity of the insect, wherever I have been in our own State; but on the contrary, have with difficulty found a single tree in any orchard that was in anywise neglected, that did not contain borers; while I have found mounded trees entirely exempt. The following paragraph communicated to the *Western Rural* by Mr. B. Pullen, of Centralia, Illinois, touches on this point, and I can bear witness to the thrift and vigor of Mr. P.'s trees:

"As spring will soon be upon us I wish to add my testimony in favor of the "banking system," as a preventive against the attacks of the peach-borer. As to its efficacy there can be no doubt. I have practiced it four years with complete success. I would not advise its adoption until after the trees are four years old. During most of this period the bark is tender, and trees are liable to be entirely girdled by even a single worm. Safety lies only in personal examination and removal with the knife, in fall and spring (September and April). In April of the fourth year bank up to the hight of from ten to twelve inches, pressing the dirt firmly around the tree. A little dirt should be added each successive spring. It is not only a preventive but a great saving of labor."

As further testimony, and with a view to giving the method by which the trees may be mounded, I also insert the following communication from E. A. Thompson, of Hillside (near Cincinnati), Ohio, which appeared in the *Journal of Agriculture*, of Nov. 14, 1868:

"The mounding system was first practiced, so far as I know, by Isaac Bolmar, of Warren county, Ohio. I visited his orchards some years ago—acquainted myself with his system—and concluded to try it upon my orchard of 4,000 trees—then one year planted. I plant my trees in the fall, and in the spring following cut them back to six inches above the bud. The tree then instead of having one body has several—from three to six. The second summer I plow both ways, turning the furrows toward the trees. The men follow with shovels, throwing the loose soil around the tree to the heighth of about one foot. In the fall I cut the trees back, taking off about one-third of the year's growth. The next spring or summer I pursue the same method, raising the mound about one foot higher; cut back in the fall, and the third summer repeat the process, raising the mound another foot, which finishes the job. The mound will then be about three feet high at its apex and six feet in diameter at its base. The mounding need not be done in the summer, or at any particular season; it is just as well done in the fall when the hurry is over. The dirt is never taken away from the trees—in fact it cannot be removed without injury to the tree—for the young rootlets each year keep climbing up through this mound. I had occasion to remove one of these mounds a few days since and found it a mass of healthy roots.

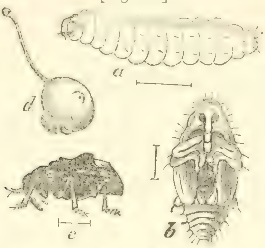
Now for the benefits. First you have no trouble with grub or borer: he must have light and air, and the mound is too much for him; he comes out and that is the last of him. I have never wormed my trees, or hunted for the borer, and an orchard of healthier or thriftier trees cannot be found. It has been asserted that the borer will re-appear again near the top of the mound—but I am satisfied this is not the case; I have never thus far been able to find one. Second, the system imparts longevity to the tree. I saw a tree in Warren county treated in this manner *thirty* (30) years old, still healthy and bearing annual crops. Third, trees thus treated are not subject to disease. I have never had a case of *yellows* in my orchard. Fourth, the expense is trifling—one man can mound fifty trees per day. The system can be applied to old as well as young orchards; but if old trees are thus treated they should be first severely cut back, when they will make a growth of young wood."

The application of soap does not appear to prevent the moth from depositing her eggs, as in the case of apple tree borers. Hot water is very efficient in killing the young borers, after the earth has been removed, and it should be applied copiously, and *hot* nigh unto the boiling point, for there is no danger of its injuring the tree. Those who grow tobacco will also find it profitable to throw the stems around the butts of their trees, as there is good evidence of its being obnoxious to the moth.

THE PLUM CURCULIO—*Conotrachelus nenuphar*, Herbst.

(Coleoptera, Curculionidæ).

[Fig. 18.]



I regret to have to state that Missouri is none the less exempt from the ruinous work of this persistent "Little Turk," than are her sister States, though I have not heard of a single instance where they have been so numerous as they were last summer in Southern Illinois; for Parker Earle, of South Pass, captured 6,500 from 100 peach trees, during the first six days of May. In every locality which I have visited, this beetle is considered *the* enemy to stone fruit, and though so much has been written about it, I find it necessary to devote a few pages to its consideration, since some of the points in its natural history are not entirely and satisfactorily settled, even yet. There is in fact conflicting evidence from different authors, as to whether it is single or double brooded each year, and as to whether it hybernates principally in the perfect beetle state, above ground, or in the preparatory states, below ground; the very earliest accounts that we have of the Plum Curculio, in this country, differing on these points. Thus, it was believed by Dr. James Tilton, of Wilmington, Deleware, who wrote at the very beginning of the present century, and by Dr. Joel Burnett, of Southborough, and M. H. Simpson, of Saxonville, Massachusetts, who both wrote interesting articles on the subject, about fifty years afterwards; that it passed the winter in the larval or grub state, under ground, and Harris seems to have held the same opinion. But Dr. E. Sanborn, of Andover, Massachusetts, in some interesting articles published in 1849 and 1850, gave as his conviction that it hybernates in the beetle state above ground. Dr. Fitch, of New York, came to the conclusion that it is two-brooded, the second brood wintering in the larva state in the twigs of pear trees; while Dr. Trimble, of New Jersey, who devoted the greater part of a large and expensive work to its consideration, decided that it is single-brooded, and that it hybernates in the beetle form above ground. Since the writings of Harris and Fitch, and since the publication of Dr. Trimble's work there have been other papers published on the subject. The first of these was a tolerably exhaustive article, by Mr. Walsh, which appeared in the *Practical Entomologist* (Vol. II, No. 7), in which he takes the grounds that the Curculio is single-brooded; though subsequently he came to the very different conclusion that it was double-brooded, (First Annual Rep., p. 67). In the summer of 1867 I spent between two and three weeks in Southern Illinois, during the height of the Curculio season, and closely watched its manœuverings. From the fact that there was a short period about the middle of July, when scarcely any could be caught from the trees, and that after a warm shower they were quite numerous, having evidently just come out of the ground,* I concluded that it was double-brooded and communicated to the *Prairie Farmer* of July 27th, 1867, the passage to that effect, under the signature of "V," which is quoted by Mr. Walsh (Rep., p. 67), as corroborative of its two-brooded character. Subsequent calculation induced me to change my mind, and I afterwards gave it as my opinion that there was but one main brood during the year, and that where a second generation was produced it was the exception, (Trans. Ills. State Hort. Soc., 1867, p. 113). Finally Dr. E. S. Hull, of Alton, Illinois, who has had vast personal experience with this insect, read a most valuable essay on the subject, before the meeting of the Alton (Ills.), Horticultural Society of March, 1868, in which he evidently concludes they are single-brooded, and that they pass the winter, for the most part, in the preparatory states, underground.

Now, why is it that persons who, it must be admitted, were all capable of correct observation, have differed so much on these most interesting points in the economy of our Plum Curculio? Is there any explanation of these contradictory statements? I think there is, and that the great difficulty in the study of this as well as of many other insects, lies in the fact that we are all too apt to generalize. We are too apt to draw distinct lines, and to create rules which never existed in nature—to suppose that if a few insects which we chance to watch are not single-brooded, therefore the species must of necessity be double-brooded. We forget that Curculios are not all hatched in one day, and from analogy, are very apt to underrate the duration of the life of the Curculio in the perfect beetle state. Besides, what was the exception one year may become the rule the year following. In breeding butterflies and moths, individuals hatched from one and the same batch of eggs on the same day, will frequently, some of them, perfect themselves and issue in the fall, while others will pass the winter in the imperfect state, and not issue till spring; and in the case

*I have often noticed, and the fact has been remarked by others, that insects which have been comparatively inactive for many days, in dry weather, fly freely after a warm shower, and it is possible that the increase of the Curculio after such rains is partly due to their flying in more vigorously from the surrounding woods.

of a green worm that is found on raspberry leaves, and which passes the winter under-ground, and develops into a four-winged fly (*Selandria rubi* of my manuscript) in the spring; I have known a difference of three months to occur between the issuing of the first and last individuals of the same brood, all the larvæ of which had entered the ground within three days. It is also a well recorded fact, both in this country and in Europe, that in 1868, owing, probably, to the unusual heat and drouth of the summer, very many insects which are well known to usually pass the winter in the imperfect state, perfected themselves in the fall, and in some instances produced a second brood of larvæ. Far be it from me to pronounce that there is no such thing as rule in nature, and that we cannot, therefore, generalize; I simply assert that we frequently draw our lines too rigidly, and endeavor to make the facts come within them, instead of loosening and allowing them to encompass the facts. It was thus that the Joint-worm fly was for so long a time suspected to be a parasite instead of the true culprit, because all the other species in the genus (*Eurytoma?*), to which it was supposed to belong, were known to be parasitic. For those who are not acquainted with the appearance of the Plum Curculio, in its different stages, I have prepared, at Figure 18, correct and magnified portraits of the full-grown *larva* (*a*); of the *pupa* (*b*) into which the larva is transformed within a little cavity underground, and of the perfect curculio (*c*).

With this prelude I will now give what I believe to be facts in its natural history, founded on my own observations of the past year, and on the observations of others. I firmly believe:

1—That Plum Curculios are a most unmitigated nuisance, and, though most beautiful objects under the microscope, the fruit-growers of the United States, if they had their own way about the matter, would wish them swept from off the face of the Earth, at the risk even of interfering with the "Harmony of Nature."

2—That they are more numerous in timbered regions than on the prairie.

3—That they *can* fly and *do* fly during the heat of the day, and that cotton bandages around the trunk, and all like contrivances to prevent their ascending the trees, are worse than useless, and a result only of ignorance of their economy.

4—That by its punctures it causes the dreaded peach-rot to spread, whenever that disease is prevalent, though it cannot possibly be the first cause of the disease. The peach-rot is now pretty generally acknowledged to be a contagious disease of a fungoid nature, and I believe that the spores of this fungus, "a million of which might be put upon the point of a stick whittled down to nothing," attach themselves more readily to fruit which has the skin abraded, and from which the gum issues, than to whole or unpunctured fruit. With this belief I made some effort to procure, for the benefit of my readers, a synopsis of the growth of this fungus; but, alas! I find that nothing but confusion exists with regard to it. Upon applying to my friend, Dr. T. C. Hilgard, of St. Louis—a recognized authority on such subjects—he furnished me with the article which may be found in the *Journal of Agriculture* of January 16th, 1869. I most respectfully declined publishing it in these pages, knowing that the reader would not be likely to understand what was either too *profound* or too befogged for my own comprehension, and those who require a *synopsis* of this fungus, are referred to that article. Verily, we must conclude that Peach-rot is not yet much understood, if a more clear exposition of it cannot be given!

5—That they prefer smooth-skinned to rough skinned fruit.

6—That up to the present time the Miner and other varieties of the Chickasaw plum have been almost entirely exempt from their attacks, and that in the Columbia plum the young larvæ are usually "drowned out" before maturing.

7—That they deposit and mature alike in nectarines, plums, apricots, cherries and peaches; in black knot on plum trees, and in some kinds of apples, pears and quinces; and, according to Dr. Hull, they also deposit but do not mature in strawberries, gooseberries, grapes, and in the vigorous shoots of the peach tree.

8—That it is their normal habit to transform underground, though some few undergo their transformations in the fruit.

9—That the cherry, when infested, remains on the tree, with the exception of the English Morello, which matures and then separates from the stem; but that all other fruits, when containing larvæ, usually fall to the ground. In the larger fruits four or five larvæ may sometimes be found in a single specimen, and I have taken five full grown larvæ from a peach that had evidently fallen and laid on the ground for over a week.

10—That the greater portion of them pass the winter in the perfect beetle state, under the old bark of both forest and fruit trees, under shingles, logs, and in rubbish of all kinds, and especially in the underbrush of the woods.

11—That they are always most numerous in the early part of the season on the outside of those orchards that are surrounded with timber, and that they frequently shelter in apple-trees and other trees before the stone fruit forms.

12—That a certain portion of them also pass the winter underground, both in the larva and pupa states, at a depth, frequently of from 2 to 3 feet.

13—That those which hybernate as beetles, begin to leave their winter quarters and to enter our orchards, throughout central Missouri, during the first days of May, and commence to puncture the fruit about the middle of the same month—a little earlier or later according to the season—the fruit of the peach being at the time about the size of a small marble.

14—That those which hybernate underground continue to develop and to issue from the earth during the whole month of May.

15—That both males and females puncture the fruit for food, by gouging hemispherical holes, but that the female alone makes the well-known crescent-shaped mark (see Fig. 18, *d.*), as a nidus for her egg.

16—That the egg is deposited in the following manner, the whole process requiring about five minutes: Having taken a strong hold on the fruit (see Fig. 18, *d*), the female makes a minute cut with the jaws, which are at the end of her snout, just through the skin of the fruit, and then runs the snout under the skin to the depth of 1-16th of an inch, and moves it back and forth until the cavity is large enough to receive the egg it is to retain. She next changes her position, and drops an egg into the mouth of the cut; then, veering round again, she pushes it by means of her snout to the end of the passage, and afterwards cuts the crescent in front of the hole so as to undermine the egg and leave it in a sort of flap; her object apparently being to deaden this flap so as to prevent the growing fruit from crushing the egg, though Dr. Hull informs me that he has repeatedly removed the insect as soon as the egg was deposited and before the flap was made, and the egg hatched and the young penetrated the fruit in every instance.

17—That the egg is oval, of a pearl-white color, large enough to be seen with the naked eye, requires a temperature of at least 70° Fahr. to hatch it, and may be crushed with the finger-nail without injuring the fruit.

18—That the stock of eggs of the female consists of from 50 to 100; that she deposits from 5 to 10 a day, her activity varying with the temperature.

19—That the last of those curculios which hybernated in the imperfect state under-ground have not finished depositing till the end of June and beginning of July, or about the time that the new brood developed from the first laid eggs of the season, are beginning to issue from the ground; and that we thus have them in the month of June in every conceivable state of existence, from the egg to the perfect insect.

20—That the period of egg depositing thus extends over more than two months.

21—That all eggs deposited before the first of July generally develop and produce Curculios the same season, which issue from the ground during July, August and September and hybernate in the perfect state.

22—That most of those which hatch after the first of July, either fail to hatch, or the young larvæ die soon after hatching, owing perhaps to the more ripe and juicy state of the fruit, being less congenial to them; and that what few do mature, which hatch after this date, undergo their transformations more slowly than the rest and pass the winter in the ground.

23—That the perfect Curculio while in the ground is soft and of a uniform red color, and that it remains in this state an indefinite period, dependent on the weather, usually preferring to issue after a warm rain.

24—That in a stiff clay soil a severe drought will kill many of them while in this last named condition, and that larvæ contained in stone fruits that fall upon naked ploughed ground where the sun can strike them, generally die.

This catalogue might be lengthened, but already embraces all the more important facts, and I think they sufficiently prove that the Curculio is single-brooded. There is, it is true, no particular reason why the earliest developed Curculios, or those which issue from the ground during the fore part of July, should not pair and deposit eggs again; other than it does not appear to be their nature to do so. Such an occurrence is by no means an isolated one in insect life, and aside from the fact that late fruit is almost entirely exempt from them, we have the experiments of Dr. Trimble which indicate that they have to pass through the winter before being able to reproduce their kind. The only other experiments that were ever made to prove the contrary hypothesis, are those detailed by Mr. Walsh, in his First Annual Report (p. 68), and, as may be seen from their perusal they prove nothing at all. To give them in his own words, I here quote them in full:

"EXPERIMENT 1ST.—On June 24th, I placed in a large glass vase, with moist sand at the bottom of it, a quantity of wild plums, every one of which I had previously ascertained to bear the crescent symbol of the 'little Turk.' During the three following weeks I added from day to day a number of plums, all of them bearing the same symbol, that had fallen from a tame plum-tree in my garden. The whole number of plums, as I subsequently ascertained, was 183, and the tame fruit probably formed about a fourth part of the whole. The first Curculio came out July 19th, and with the exception of July 21st and August 1st, there were more or less came out every day till August 4th, inclusive; after which day no more came out. The numbers coming out on each successive day were as follows, the very large number on July 25th having beeu probably caused by my wetting the sand on that morning rather copiously: 1, 18, 0, 3, 4, 2, 55, 8, 4, 3, 1, 2, 1, 0, 5, 4, 2. Total, 113. On examining the contents of the vase, November 29th, I found five dead and dried up Curculios among the plums, and among the sand sixteen dead and immature specimens, which had obviously failed to make their way up to the light of day, besides the remains of a good many individuals which had perished in the sand in the larva or pupa state, and were not counted. The Grand Total from 183 infested plums was, therefore, 134 Curculios in the beetle state, and an unknown number of larvæ and pupæ."

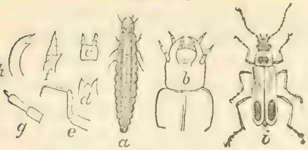
"EXPERIMENT 2d.—On July 27th, or eight days before the Curculios in the preceding experiment had ceased coming out, I placed in a vase, similar to the above, 243 plums, gathered promiscuously off some badly-infested wild plum-trees. From this lot no Curculios whatever came out till August 23d, and from that day, until September 14th, more or less came out daily, with the exception of five out of the 23 days, the numbers on the respective days being as follows: 3, 1, 2, 2, 2, 3, 2, 2, 5, 3, 1, 0, 5, 6, 3, 2, 0, 0, 0, 1, 0, 1, 1. Subsequently, on September 18th, there came ont 3, on Septembar 24th, 1, and on September 28th, 1; after which no more made their appearance. Total, 50 Curculios from 243 plums, some stung and some not. On examiuing the contents of this vase on November 29th, I found a single dead Curculio among the plums, making a Grand Total of 51 Curculios bred from these plums. There were no specimens, either in larva, pupa or beetle state, to be found among the sand in the vase on November 29th; which was, perhaps, due to the contents having kept much moister than those of the first vase, though on July 25th I had, as I thought, moistened the sand in the first vase quite sufficiently."

Now because there was an intermission of 19 days when no Curculios came out, Mr. Walsh arrives at once to the conclusion that there are two distinct broods, the second of which is, "of course" generated by the first. If the infected plums had been collected and placed in vases day by day, or if the curculios bred in the first experiment had been furnished with fresh plums and had actually paired and deposited again, the experiments would have been satisfactory; but as they stand, they seem to me, on the very face, to forbid the conclusions to which the experimenter arrived. In both these experiments the very result was obtained that might have been expected, for I have myself proved, that with favorable conditions the Curculio remains under ground about 3 weeks, and as there would naturally be none advanced beyond the full grown larva state, when first put into the vase, perfect Curculios could not possibly appear till they had had time to transform, or in other words, till about three weeks after the plums were placed in the vase. Thus from the plums placed in the vase on the 24th of June the first Curculios appeared on the 19th of July—25 days afterwards; while from those placed in the second vase on July 27th, the first Curculios appeared on the 23d of August—27 days afterwards. The interval also, of 19 days which elapsed between the issuing of the last Curculios in the first experiment and the first curculios in the last experiment, was exactly what should have been expected, since the plums were placed in the second vase eight days before the last curculios in the first vase had issued. Had the plums been placed in the second vase 10 days earlier or 10 days later, there would have been an intermission of 9 or 29 days accordingly, in their coming out, etc., etc. Moreover, a period of at least 50 days elapses between the deposition of an egg and the time required for that egg to develop into a Curculio and even on the supposition that the female commenced depositing the moment she left the ground, which is certainly not the case, the Curculios bred in the second vase could not possibly have been the progeny of any that appeared contemporaneously with those bred from the first vase.

NATURAL REMEDIES.—There is no very good evidence that any true parasites infest the Curculio, and though it was well known that ants attacked and killed the larvæ as they left the fruit to enter the ground, yet until the present year no other cannibals were known to attack it; but Mr. Walsh in his interesting account of a trip through Southern Illinois has shown that there are several cannibal insects which habitually prey upon it. From this account which was published in the AMERICAN ENTOMOLOGIST—pp. 33-35—I condense the following facts.

The Pennsylvania Soldier beetle (*Chauliognathus pennsylvanicus*, DeGeer).—This beetle which is represented at Figure 19, *i* is of a yellow color, marked with black. It is a common species and I have found it quite abundant in our own State on the flowers of the Golden-rod during the months of September and October. Its larva (Fig. 7, *a*) is one of the most effectual destroyers of the Curculio while the latter is above ground in the larva state. It attacks the Curculio grub within the fruit while it yet hangs on the tree, and also enters the fruit which falls to the ground, for the same purpose. In the summer of 1867 I found this same larva on an apple tree of the Early Harvest variety, the fruit of which contained Curculio larvæ from which I subsequently bred perfect Curculios. It is quite active in its movements, and the general color is smoky brown, with a velvety appearance, and for the benefit of those interested I subjoin the technical desription of it:

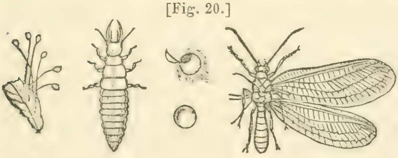
[Fig. 19*.]



Chauliognathus pennsylvanicus, DeGeer—*Larva*—Head shining rufous, with two black patches behind, transversely arranged; labrum retractile, dark colored, horny and deeply emarginate with a central tooth; maxillary palpi 4-jointed; labial palpi 2-jointed; antenna 3-jointed, the last joint very small; body rather flattened, of an opaque velvety-brown color above, with a somewhat darker subdorsal line, which is widened on the three thoracic segments; a very distinct lateral spiracle to every segment of the body except the anal one, making altogether eleven pairs of spiracles, all of them exactly alike, and in range with each other. Body beneath suddenly very pale brown, the dividing line between the darker and the paler shades of brown upon each segment being a semicircular curve, with its concavity upward; legs six; a moderate anal proleg; length 0.65 inch.

Lacewing larva.—The larvæ of our lacewing flies (*Chrysopa*) seem to have the same habit of attacking Curculio grubs above ground, and great numbers of them were found in the act last summer by Mr. E. Leming, of Cobden, Illinois. The particular species which those belonged to that were occupied in this good manner, has not yet been ascertained, but as they are all known to be cannibals it is possible that more than one species have this praiseworthy habit, though their general food consists of plant-lice. The lacewing flies are common all over the country, and may at once be recognized by their delicate green bodies, lace-like wings and by their brilliant golden eyes; but more especially by a peculiarly disagreeable odor which they are capable of emitting when handled. Our American lacewings, like those of Europe, are capable of emitting this odor, and those who have once experienced it require no description to recall it. One of these

[Fig. 20.]



a b c d

*Explanation of Figure 19—*h* the left upper jaw (*mandible*), *f* the left lower jaw (*maxil*), *c* the under lip (*labium*), *d* the upper lip (*labrum*), *g* the antenna, *e* one of the legs, *a* the larva natural size, *b* head and first segment of same enlarged.

flies, with the left wings cut off to save space, is represented at Figure 20 *d*, and a typical larva is represented in outline in the same figure at *b*. The female deposits her eggs upon different plants, attaching them at the extremity of a long and very slender foot-stalk (see Fig. 20, *a*). This filament is composed of a viscid matter which she discharges and which quickly hardens on exposure to the atmosphere. We see here, as everywhere else in Nature, an Allwise creative forethought, and a wonderful adaptation to a particular end, in the instinct which prompts, and the power which enables the female lacewing to thus deposit her eggs; for the newly hatched larvæ are so exceedingly voracious that the first hatched would devour the eggs which yet remained unhatched, if they could but reach them.

The larvæ when full-grown spin perfectly round white cocoons (Fig. 20, *c*), by means of a spinneret with which they are furnished at the extremity of the body, and they attach them with threads of loose silk to the underside of fences and in other sheltered situations. These cocoons are of an extraordinary small size compared with the larva which spins them, or with the perfect insect which escapes from them, as may be readily seen by referring to the above figures which bear the relative proportions. After completing the cocoon, I think the larva partly cuts a circle at one side severing the fibers sufficiently to enable their ready separation; for in issuing, the pupa pushes open a small lid, which is cut perfectly smooth, and just spirally enough to allow it to hang at one end as on a hinge. I have also noticed another fact, which, so far as I am aware, has not been recorded by any previous writer, which is, that the insect issues from this cocoon in an active sub-imago state, from which after a few hours the winged fly emerges, leaving behind it a fine silvery-white transparent skin.

[Fig. 21.]

THE SUBANGULAR GROUND BEETLE—(*Aspidiglossa subangulata*, Chaud.)—This small polished black beetle which is represented enlarged at Figure 21, the hair line at the side showing the natural size, also, in all probability serves us a good turn in helping to diminish the numbers of the Curculio, for Mr. Walsh found him in a peach that had contained Curculio grubs, and as the great family of beetles (*Carabus*) to which he belongs are all cannibals so far as is known, and as he was therefore evidently not inside the peach for the fruit itself, he is to be strongly suspected of being a Curculio hunter. To adopt Shakespeare's mode of reasoning:

> "Who finds the heifer dead, and bleeding fresh,
> And sees fast by a butcher with an axe,
> But will suspect 'twas he that made the slaughter?"

The Curculio is not even safe from the attacks of cannibals when underground, for the larva which is represented of the natural size at Figure 22, *A*, seeks it in its hiding place and mercilessly devours it. This larva is of a shining brown-black color above, and dull whitish beneath, and I subjoin herewith the technical description:

[Fig. 22.*]

Shining brown-black and horny above; thorax immaculate above; sutures and sides of the abdominal dorsum, and all beneath, except the head, pale dull greenish white; a narrow, horny, elongate, abbreviated lateral dark stripe on the dorsum of each of the abdominal joints (4—12); joints 4—10 beneath, each with seven pale-brown horny spots, namely, a large subquadrate spot followed by two small dots in the middle, an elongate spot on each side, and between that and the two medial small dots a second elongate spot, only half the length and breadth of the lateral one (Fig. 22, *j*); joint 11 beneath has only the medial subquadrate spot and the lateral elongate one (Fig. 22, *i*); and joint 12 beneath has nothing but the subquadrate spot (Fig. 22, *h*); legs six, of a pale rufous color; the usual elongate carabidous proleg on joint 12, and on each side of its tip an elongate exarticulate cercus, garnished with a few hairs; antennæ four-jointed; labial palpi two-jointed; maxillary palpi four-jointed. Length 1.25 inch.

This larva has not yet been bred to the perfect state, but belongs undoubtedly to some one of the Ground-beetles, and not improbably to the Pennsylvania Ground-beetle, (*Harpalus pennsylvanicus*, DeGeer), a dull black species represented at Figure 23. All these Ground-beetles are our friends however, and should always be cherished and not crushed, as they are very apt to be from their habit of crawling and living on the ground. It is safe to infer, that all beetles approaching the annexed form, with active movements, and generally dull colors, which are observed running over the ground, are friends, and should therefore be saved.

[Fig. 23.]

Hogs.—Before leaving the subject of natural remedies, I feel in duty bound to say a few words in favor of hogs as Curculio destroyers. Abundant proof might be adduced of their utility in an orchard, especially during the fruit season, but I will mention only the case of Messrs. Winters Bros., of Du Quoin, Ills. These gentlemen, for the past five years, have kept a large drove of hogs in their extensive peach orchard, and have been remarkably exempt from the attacks of the Little Turk. While at their place last fall, I noticed that all the trees were banked up with earth to the height of over a foot, which prevented the hogs from injuring the trunks. They have never had occasion to shake their trees, and consider one hog to the acre sufficient to devour all the fallen fruit, the hogs being fed only during the winter. The efficacy of this hog remedy depends a great deal on how much one's orchard is isolated from those of others, for it is very evi-

* Explanation of Figure 22.—*B* represents the under side of the head, showing at *c* the upper jaw (*mandible*), at *g* the lower jaw (*maxil*), with its fonr-jointed feelers (*palpi*), at *f* the lower lip (*labium*), with its two-jointed feelers (*palpi*), and at *e* the *antennæ*.

dent that it will avail but little for one person to destroy all his Curculio while his neighbors are breeding them by thousands, so that they can fly in upon him another year. They would also be of but little service in the case of the cherry, as it remains on the tree when stung. Poultry will be found valuable in an orchard as they also devour the grubs which fall with the fruit.

Artificial Remedies.—Of the hundreds of patent nostrums, and of the dozens of washes and solutions that have been recommended as Curculio preventives or destroyers, there is scarcely one which is worth the time required to speak of it. Air-slacked lime thrown on the trees after the fruit is formed, is effectual in a certain measure, for though it does not deter the female from depositing her eggs, yet so long as the weather is wet, its caustic properties seem to be imparted to the water and enter the cavity and destroy the egg. But it has no good effect in dry weather. An article went the rounds of the papers last Summer, to the effect that Mr. P. E. Rust, of Covington, Ky., had tried burning tobacco stems with *perfect success!* But a letter of inquiry which I addressed to that gentleman was never answered, although it contained the requisite 3-cent postage stamp, and the tobacco remedy may be placed by the side of the Gas-tar and Coal-tar remedies, which have proved utterly useless. After all, as Dr. Hull, suggests, the successes, so reported, of these remedies, take their origin from insufficient experiment, by persons who are little aware of the casualties to which the Curculio is subject, and who, if they happen to get fruit after applying some particular mixture, immediately jump to the conclusion that it was on account of such mixture.

It may therefore be laid down as a maxim, that the only effectual and scientific mode of fighting the Curculio, aside from that of picking up the fallen fruit, is by taking advantage of its peculiar instinct which on approach of danger prompts it to fall; or in other words to catch it by jarring the tree. The most effectual method of doing this on a large scale is by means of Dr. Hull's "Curculio catcher," and I give a description of it in the Doctor's own words:

"To make a curculio catcher we first obtain a light wheel, not to exceed three feet in diameter, the axletree of which should be about ten inches long. We next construct a pair of handles, similar to those of a wheelbarrow, but much more depressed at the point designed to receive the bearings of the axletree, and extending forward of the wheel just far enough to admit a crossbeam to connect the handles at this point; one-and-a-half inches in the rear of the wheel a second cross beam is framed into the handles, and eighteen to twenty-four inches further back, a third. The two last named cross-beams have framed to their under-sides a fourth piece, centrally, between the handles, and pointing in the direction of the wheel. To the handles and to the three last named pieces, the arms or ribs to support the canvass are to be fastened. To the front part of the beam connecting the handles in front of the wheel, the ram is attached, this should be covered with leather stuffed with furniture moss, a dozen or more thicknesses of old hat, leather or other substance, being careful to use no more than necessary to protect the tree from bruising. Ascertain the elevation the handles should have in driving, and support them in that position. We now put in place the stretchers or arms, six for each side, which are to receive and support the canvas. We put the front arms in position. These extend back to near the centre of the wheel on each side, and in front of the wheel (for large machines) say six feet, and are far enough apart to receive the largest tree between them on which it is intended to operate. The remaining arms are supported on the handles, and fastened to them and to the two cross and parallel pieces in the rear of the wheel. These are so placed as to divide the space at their outer ends equally between them and the first mentioned stretchers and fastened to the ends of the handles. Next we have ready a strip of half-inch board two an a half wide. One end of this is secured to the forward end of one of the front arms, and in like manner to all the others on one side of the machine, and fastened to the handles. Both sides are made alike. The office of these strips is to hold the outside ends of the arms in position; they also hold the front arms from closing. These outside strips also receive the outside edge of the canvas, which is fastened to them as well as the several arm supports.

"It will be seen that the wheel is nearly in the center of the machine. To cover the opening at this point, a frame is raised over it, which is also covered with canvas. The arms, or stretchers, are so curved that the motion of the machine, in moving from one tree to another, should bring everything falling on the canvas to depressed points, one on each side of the wheel, where openings are made into funnels emptying into pockets or bags, for the reception of insects and fallen fruit. The whole machine should not exceed ten or eleven feet in breadth, by twelve or thirteen in length. These are for large orchard trees; smaller ones could be protected with a much smaller machine. If the frame work has been properly balanced, the machine will require but little lifting, and will be nearly propelled by its own weight.

"This curculio catcher, or machine, is run against the tree three or four times, with sufficient force to impart a decided jarring motion to all its parts. The operator then backs far enough to bring the machine to the center of the space between the rows, turns round and in like manner butts the tree in the opposite row. In this way a man may operate on three hundred trees per hour."

To run this machine successfully three things are necessary: 1st, that the land be decently clean, and not overgrown with rank weeds; 2d, that the orchard be sufficiently large to pay the interest on the prime cost of the machine—about $30; 3d, that the trees have a clean trunk of some three or four feet. I find various modifications of this machine, both in our own State and in Southern Illinois, and in some instances they have been abandoned entirely on account of the injury caused to the trees from the repeated blows given to the trunk. In small orchards it will be found most profitable to drive a spike into the trunk of each tree and to use two sheets stretched on frames, which can both be dragged or carried and placed in position by one man, while a second person gently taps the iron spike with a mallet. To bring the Curculio down, it requires a light, *sudden* tap which jars, rather than a blow which shakes, and if the frames are each made so as to fold in the middle, it will facilitate disposing of those which fall upon it.

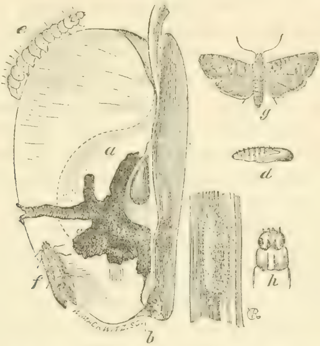
In conclusion, the intelligent fruit-grower can draw many a lesson from this account of the Curculio—already somewhat lengthy. Thus in planting a new orchard with timber surrounding, the less valuable varieties should be planted on the outside, and as the little rascals congregate on them from the neighboring woods in the early part of the season, they should be fought persistently. It will also pay to thin out all fruit that is known to contain grubs, and that is within easy reach; while wherever it is practicable all rubbish and underbrush should be burnt during the winter, whereby many, yes *very many* of them will be destroyed in their winter quarters. As a proof of the value of this measure when it is feasible, I will state that while the peach crop of Southern Illinois was almost an entire failure in 1868, Messrs. Knowles & Co., who have 70 acres of peach orchard 1¼ miles N. W. of Makanda, shipped over 9000 boxes. Though they had a few hogs in the orchard, there were not enough to do any material good, and they think they owe their crop to the fact of having cleared and burnt 100 acres surrounding the orchard, in the early spring of that year; for in 1867 the Curculios had been very bad with them. Judge Kimble, who lives 4 miles N. E. of Cobden, also had a good crop free from their marks, which he attributes to having burnt around the orchard in the spring of the year.

THE CODLING MOTH OR APPLE-WORM—*Carpocapsa pomonella*, Linn.

(Lepidoptera, Tortricidæ.)

The Apple-worm, I find to be quite common all over the State, as it is in almost all parts of the civilized world where apples are grown. Dr. Trimble has devoted page after page to the consideration of this little pest, and yet its whole history and the means of preventing its insidious work may be given in a very few lines. It was originally a denizen of the Old World, but was introduced into this country about the beginning of the present century. The following figure represents it in all its states, and gives at a glance its natural history: *a* represents a section of an apple which has been attacked by the worm, showing the burrowings and channel of exit to the left; *b*, the point at which the egg was laid and at which the young worm entered; *e*, the full

[Fig. 24]



grown worm; *h*, its head and first segment magnified; *i*, the cocoon which it spins; *d*, the chrysalis to which it changes; *f*, the moth which escapes from the chrysalis, as it appears when at rest; *g*, the same with wings expanded. The worm when young is whitish, with usually an entirely black head and a black shield on the top of the first segment. When full grown it acquires a flesh-colored or pinkish tint, especially on the back, and the head and top of first segment become more brown, being usually marked as at Figure 24 *h*. It is sparsely covered with very minute hairs which take their rise from minute elevated points, of which there are eight on each segment. The cocoon is invariably of a pure white color on the inside, but is disguised on the outside by being covered with minute fragments of whatever substance the worm happens to spin to. The chrysalis is yellowish brown, with rows of minute teeth on its back, by the aid of which it is enabled to partly push itself out of its cocoon, when its time to issue as a moth arrives. The moth is a most beautiful object; yet, as has been well remarked by an anonymous writer,* from its habits not being known it is seldom seen in this state, and the apple-grower as a rule, "knows no more than the man in the moon to what cause he is indebted for the basketfuls of worm-eaten windfalls in the stillest weather." Its fore wings are marked with alternate, irregular transverse wavy streaks of ash-gray and brown, and have on the inner hind angle a large tawny brown spot, with streaks of bright bronze color or gold.

The apple is, so to speak, our democratic fruit, and while stone fruit is grown but in certain regions, this is cultivated all over the country. The Codling moth is then even more injurious than the Curculio. Unlike the Curculio, it is mostly two-brooded, the second brood of worms hybernating in the larval state, inclosed in their snug

* Entomological Magazine, London, Vol. I, p. 144.

little silken houses, and ensconced under some fragment of bark or other shelter. The same temperature which causes our apple trees to burst their beauteous blossoms, releases the Codling moth from its pupal tomb, and though its wings are at first damp with the imprint of the great Stereotyping Establishment of the Almighty, they soon dry and expand under the genial spring-day sun, and enable each to seek its companion. The moths soon pair, and the female flits from blossom to blossom, deftly depositing in the calyx of each a tiny yellow egg. As the fruit matures, the worm develops. In thirty-three days, under favorable circumstances, it has become full-fed; when, leaving the apple, it spins up in some crevice, changes to chrysalis in three days, and issues two weeks afterwards as moth, ready to deposit again, though not always in the favorite calyx this time, as I have found the young worm frequently entering from the side. Thus the young brood of Codling moths appear at the same time as the young Curculios, the difference being that instead of living on through fall and winter, as do the latter, they deposit their eggs and die, it being the progeny from these eggs which continues the race the ensuing year. Though two apples side by side may, the one be maturing a Curculio, the other a Codling moth, the larva of the latter can always be distinguished from the former by having six horny legs near the head, eight fleshy legs in the middle of the body, and two at the caudal extremity, while the Curculio larva hasn't the first trace of either.

In latitude 38° the moths make their appearance about the first of May, and the first worms begin to leave the apples from the 5th to the 10th of June and become moths again by the fore part of July. While some of the first worms are leaving the apples, others are but just hatched from later deposited eggs, and thus the two broods run into each other; but the second brood of worms (the progeny of the moths which hatch out after the first of July), invariably passes the winter in the worm or larval state, either within the apple after it is plucked, or within the cocoon. I have had them spin up as early as the latter part of August, and at different dates subsequently till the middle of November, and in every instance, whether they spun up early or late in the year, they remained in the larval state till the middle of April, when they all changed to chrysalids within a few days of each other. Furthermore, they not only remain in the larval state, but in many instances where I have had them in a warm room, they have been *active* throughout the winter, and would always fasten up the cuts made in their cocoons, even where the operation was performed five and six times on the same individual. These active worms perfected themselves in the spring as well as those which had not been disturbed, and this fact would indicate that the torpid or dormant state, so called, is not essential to the well being or the prolongation of life of some insects.

Though the Codling moth prefers the apple to the pear, it nevertheless breeds freely in the latter fruit, for I have myself raised the moth from pear-boring larvæ, and the fact was recorded many years, ago by the German entomologist, Kollar. It also inhabits the fruit of the crab-apple and quince, and is not even confined to pip-fruit, for Dr. T. C. Hilgard, of St. Louis, bred a specimen, now in my cabinet, from the sweetish pulp of a species of screw-bean (*Strombocarpa monoica*) which grows in pods, and which was obtained from the Rocky Mountains, while Mr. Wm. Saunders, of London, Ontario, Canada, has also found it attacking the plum in his vicinity.* This is entirely a new trait in the history of our Codling moth, and is another evidence of the manner in which certain individuals of a species may branch off from the old beaten track of their ancestors. This change of food sometimes produces a change in the insects themselves, and it would not be at all surprising, if this plum-feeding sect of the Codling moth, should in time show variations from the normal pip-fruit feeding type. As Mr. Saunders is a well known entomologist, it is not likely that he has been mistaken in the identification of the species, for the only other worm of this character which is known to attack the plum in America, is the larva of Mr. Walsh's Plum moth (*Semasia prunivora*) which is a very much smaller insect than the Codling moth. Mr. Saunders says that his plum crop suffered considerably from this cause and that the operation appeared to be performed by the second brood, the plums falling much later than those stung by the Curculio—remaining in fact on the tree till nearly ripe. I do not think that this insect has yet acquired an appetite for the plum in the States. As a general rule, there is but a single worm in each apple, but two are sometimes found in one and the same fruit.

Remedies.—Though with some varieties of the apple, the fruit remains on the tree till after the worm has left it, yet by far the greater portion of the infested fruit falls, prematurely with the worm, to the ground; hence much can be done toward diminishing the numbers of this little pest by picking up and destroying the fallen fruit as soon as it touches the ground. For this purpose, hogs will again be found quite valuable, when circumstances allow of their being turned into the orchard. Abundant testimony might be given to prove this, but I make room only for the following from Mr. Suel Foster, of Muscatine, Iowa, whom I know to be abundantly capable of forming a proper judgment:

"I have twenty-four acres of my orchards seeded to clover, and last year I turned the hogs in. I now observe that where the hogs ran last year, the apples have not one-fourth the worms that they have on other trees. I this year turned the hogs into my oldest (home) orchard.†"

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* Report of the Commissioner of Agriculture and Arts, of the Province of Ontario, for the year 1868, page 200.

† Transactions Illinois State Horticultural Society, 1867, page 213.

Mr. Huron Burt, of Williamsburg, Mr. F. R. Allen, of Allenton and Mr. Varnum, of Sulphur Springs, have also, each of them, testified to me as to the good effects obtained from allowing hogs the run of their orchards.

There is, however, a more infallible remedy, and one which is always practicable, It is that of entrapping the worms. This can be done by hanging an old cloth in the crotches of the tree, or by what is known as Dr. Trimble's hay-band system, which consists of twisting a hay-band twice or thrice around the trunk of the tree. To make this system perfectly effectual, I lay down the following as rules: 1*st*, *the hay-band should be placed around the tree by the first of June, and kept on till every apple is off the tree ;* 2*d*, *it should be pushed up or down, and the worms and chrysalids crushed that were under it, every week, or at the very latest, every two weeks ;* 3*d*, *the trunk of the tree should be kept free from old rough bark, so as to give the worms no other place of shelter, and*, 4*th*, *the ground itself should be kept clean from weeds and rubbish.* But, as already stated on a previous page, many of the worms of the second brood yet remain in the apples even after they are gathered for the market. These wormy apples are barrelled up with the sound ones, and stored away in the cellar or in the barn. From them the worms continue to issue, and they generally find plenty of convenient corners about the barrels in which to form their cocoons. Hundreds of these cocoons may sometimes be found around a single barrel, and it therefore becomes obvious that, no matter how thoroughly the hay-band system had been carried out during the summer, there would yet remain a sufficiency in such situations to abundantly continue the species another year. And when we consider that every female moth which escapes in the spring, lays from two to three hundred eggs, and thus spoils so many apples, the practical importance of thoroughly examining, in the spring of the year, all barrels or other vessels in which apples have been stored becomes at once apparent. It should, therefore, also be made a rule to destroy all the cocoons which are found on such barrels or vessels either by burning them up or by immersing them in scalding hot water.

Now, there is nothing in these rules but can be performed at little trouble and expense. Their execution must henceforth be considered a part of apple-growing. Let every apple-grower in Missouri carry them out strictly, and see that his neighbors do likewise, and fine, smooth, unblemished fruit will be your reward!

The philosophy of the hay-band system is simply that the worms, in quitting the fruit, whether while it is on the tree or on the ground, in their search for a cozy nook, in which to spin up, find the shelter given by the hay-band just the thing, and in ninety-nine cases out of a hundred, they will accept of the lure, if no other more enticing be in their way. I have thoroughly tested this remedy the past summer, and have found it far more effectual than I had anticipated, wherever the above rules were recognized. Under two hay-bands which were kept around a single old isolated tree, through the months of June, July and August, I found every week of the last two months an average of fifty cocoons.

I have often smiled in my journeyings through the State, to see the grin of incredulity spread over the face of some unsophisticated farmer as I recounted the natural history of this Codling moth, and urged the application of the hay-band. Magic spell or fairy tale could not more thoroughly have astounded some of them than the unmasking of this tiny enemy and the revealing of the proper preventive.

The burning of fires has been recommended, under the supposition that the moths will fly into them and get destroyed. I have no faith whatever in the process, so far as regards this particular species, for though it is true that the moths fly and deposit their eggs in the evening, I do not believe they are attracted to the light, as are some others, for I have never been able to thus attract any myself.

CUT-WORMS.

(Lepidoptera Noctuidæ.)

THE NATURAL HISTORY OF TWELVE DISTINCT SPECIES.

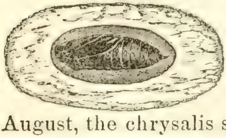
There are several different kinds of insects that are known by the popular name of cut-worm. Thus, the White grub, or larva of the common May beetle (*Lachnosterna quercina*, Knoch), and the different species of wire-worms, the larvæ of our Click beetles (*Elater* family) are all called cut-worms in some part or other of the United States. But I shall confine the term to those caterpillars, which, for the most part, have the habit of hiding just under the surface of the earth during the day, and feeding either on the roots, stems or leaves of plants during the night.

Most of these caterpillars have the very destructive habit of cutting, or entirely severing the plant on which they feed, just above or below the ground. On this account they have received the name of *Cut*-worms, and not because when cut in two, each end will reproduce itself as some people have supposed; for although some polyps and other animals belonging to the great class RADIATA in the animal kingdom, have this curious power of multiplying by division, it is not possessed by any insect, and after having mutilated one of these cut-worms, the farmer need never fear that he has thereby increased, instead of having decreased their number. From this habit of cutting, they prove a far greater nuisance than if they were to satisfy their appetites in an honest manner. In the latter case we might feel like letting them go their way in peace, but as with the Baltimore oriole, which abrades and ruins a hundred grapes where it would require one for food, we feel vexed at such wanton destruction of our products, and would gladly rid ourselves of such nuisances.

These caterpillars are called surface caterpillars in England, in which country, as well as on the continent of Europe, they have long been known to do great damage to vegetables, and especially to the cabbage, mangel-wurzel and turnip. There are many different species and they vary in size and detail of markings; but all of them are smooth, naked and greasy-looking worms of some shade of green, gray, brown or black, with a polished, scaly head, and a shield of the same color on the top of the first and last segments; while most of them have several minute shiny spots on the other segments, each spot giving rise to a minute stiff hair. They also have the habit of curling up in a ball when disturbed, as shown at Figure 2, in Plate 1. They produce moths of sombre colors which are known as Owlet or Rustic moths, and the species that have so far been bred in this country, belong to one or other of the four genera, *Agrotis*, *Hadena*, *Mamestra* or *Celæna*. These moths fly, for the most part by night, though some few of them may be seen flying by day, especially in cloudy weather. They frequently, even in large cities, rush into a room, attracted by the light of gas or candle, into which they heedlessly plunge and singe themselves. They rest with the wings closed more or less flatly over the body, the upper ones entirely covering the lower ones, and these upper wings always have two, more or less distinctly marked spots, the one round, the other kidney-shaped.

The natural history of most of these cut-worms may be thus briefly given. The parent moth attaches her eggs to some substance near the ground, or deposits them on plants, mostly during the latter part of summer, though occasionally in the spring of the year. Those which are deposited during late summer, hatch early in the fall, and the young worms, crawling into the ground feed upon the tender roots and shoots of herbaceous plants. At this time of the year, the worms being small and their food plentiful, the damage they do is seldom noticed. On the approach of winter they are usually about two-thirds grown, when they descend deeper into the ground, and, curling themselves up, remain in a torpid state till the following spring. When spring returns, they are quite ravenous, and their cutting propensities having fully developed, they ascend to the surface and attack the first green succulent vegetation that comes in their way. When once full grown they descend deeper into the earth, and form for themselves oval chambers, in which they change to chrysalids, as shown in the annexed cut (Fig. 25). In this state they remain from two to four weeks, and finally come forth as moths, during the months of June, July and August, the chrysalis skin, being in most cases so thin, that it is impossible to preserve it. These moths in time lay eggs, and their progeny goes through the same cycle of changes. Some species, however, as I shall presently show, are most likely two-brooded, while others pass through the winter in the chrysalis state.

[Fig. 25].



Dr. Fitch states that he had great difficulty in breeding these cut-worms to the perfect moths, "as the worms on finding themselves imprisoned, hurriedly crawl around and around the inner side of their prison, night after night, until they literally travel themselves to death." Consequently the natural history of but one or two of them has hitherto been known. I have found, however, that by giving them the proper conditions they are not so very difficult to breed, and after giving some account of a certain class of cut-worms which have the habit of climbing up trees, I will briefly describe those species which I have traced through their transformations, so that they may be readily recognized, and afterwards suggest the proper remedies.

CLIMBING CUT-WORMS.

Orchardists in spring frequently find the hearts of their fruit buds —on young trees especially—entirely eaten out and destroyed, and this circumstance is attributed to various causes, winged insects, beetles, slugs for instance; or even to late frosts, unsuitable climate, etc. Never have cut-worms received the blame, all of which should be ascribed to them, for the game hold of many species on a sandy soil in early spring, is the fruit tree. This is a very important fact to fruit raisers, and let those who have essayed to grow the dwarf apple and pear, on a sandy soil, and have become discouraged, as many have, from finding their trees affected each year in this way, take hope; for knowing the cause, they may now easily prevent it.

These climbing cut-worms will crawl up a tree eight or ten feet high, and seem to like equally well the leaves of the pear, apple and grape.

They work during the night, always descending just under the surface of the earth again at early dawn, which accounts for their never having been noticed in this their work of destruction in former years. They seldom descend the tree as they ascend it, by crawling, but drop from the bud or leaf on which they have been feeding; and it is quite interesting to watch one at early morn when it has become full fed and the tender skin seems ready to burst from repletion, and see it prepare by a certain twist of the body for the fall. This fact also accounts for trees on hard, tenacious soil, being comparatively exempt from them, as their instinct doubtless serves them a good turn either in preventing them from ascending or by leading the parent moth to deposit her eggs by preference on a light soil.

These facts were published in the *Prairie Farmer* of June 2, 1866, accompanied with descriptions by myself of three of the worms that were found to have this habit; and the observations were made on Mr. J. W. Cochran's farm at Calumet, Illinois. In speaking of these same climbing cut-worms, in the same article Mr. Cochran says:

"They destroy low branched fruit trees of all kinds, except the peach, feeding on the fruit buds first, the wood buds as a second choice, and preferring them to all other things, tender grape buds and shoots (to which they are also partial) not excepted—the miller always preferring to lay her eggs near the hill or mound over the roots of the trees in the orchard; and if, as is many times the case, the trees have a spring dressing of lime or ashes with the view of preventing the May beetles' operations, this will be selected with unerring instinct by the miller, thus giving her larvæ a fine warm bed to cover themselves up in during the day from the observations of their enemies. They will leave potatoes, peas and all other young green things for the buds of the apple and the pear. The long, naked young trees of the orchard are almost exempt from their voracious attacks, but I have found them about midnight, of a dark and damp night well up in the limbs of these. The habit of the dwarf apple and pear tree however just suits their nature, and much of the complaint of those people who can not make these trees thrive on a sandy soil, has its source and foundation here, though apparently utterly unknown to the orchardist. There is no known remedy; salt has no properties repulsive to them, they burrow in it equally as quick as in lime or ashes. Tobacco, soap and other diluted washes do not even provoke them; but a tin tube 6 inches in length, opened on one side and closed around the base of the tree, fitting close and entering at the lower end an inch into the earth, is what the lawyers would term an effectual estopper to further proceedings.

"If the dwarf tree branches so low from the ground as not to leave 6 inches clear of trunk between the limbs and ground, the limbs must be sacrificed to save the tree—as in two nights four or five of these pests will fully and effectually strip a four or five year old dwarf of every fruit and wood bud, and often when the tree is green, utterly denude it of its foliage. I look upon them as an enemy to the orchard more fatal than the canker worm when left to themselves, but fortunately for mankind more surely headed off."

Harris gives us the earliest intimation of this climbing character in these worms, on page 450 of his work, where he says, that "in the summer of 1851, an agricultural newspaper contained an account of certain naked caterpillars, that came out of the ground in the night, and crawling up the trunks of fruit-trees, devoured the leaves, and returned to conceal themselves in the ground before morning." But until the above article, from which I have quoted, was published, the fact was not generally known and none of the species had been identified.

They seem to prefer the apple, pear and grape-vine, though they also attack the blackberry, raspberry, currant, and even rose-bushes and ornamental trees. Nor do they confine themselves to dwarf trees, as the following extract from a letter by John Townley, of Marquette Co., Wis., to the *Practical Entomologist* for March, 1867, abundantly proves.

"During the last two years at least, young apple-trees in this locality have been much injured by having their buds destroyed. My observations last spring led me to conclude, that a worm very like the cut-worm, and having the same habit of hiding just beneath the surface of the soil during the day and feeding by night, was the cause of the mischief. * * * * * *

"Soon after snow had gone in 1865, I pruned a lot of apple-trees then four years planted. The wood at the time seemed alive and sound. When older trees were coming into leaf, these remained almost destitute of foliage; and on examining them, it was found, that most of the buds, especially those on shoots formed the preceding year, were gone—removed as clean as if they had been picked out with a point of a knife. The bark in small patches near the ends of some of the shoots had also been eaten or chipped off. As many small birds had been seen about the trees, the conclusion was arrived at that they had probably eaten the buds. In the fall, mounds of earth were thrown up around the stems of these trees, and of another lot two years planted. These mounds were being leveled on the 6th of May last; and soon after commencing the work, several large cut-worms like grubs were noticed. This, coupled with the fact, that in the preceding spring, I had caught a worm like these in the very act of eating out a bud high up the stem of a young Catalpa, around which I had thrown a blanket the evening before, to shield it from frost, induced me to suspect that they and not the birds destroyed the buds. This led to an examination of the untouched mounds; and in the soil immediately surrounding the stem of each tree, I found from about five to ten of these worms. Twenty-three were taken from the soil around a plant of the Rome Beauty apple. * * * On a warm dewy night about the middle of the month, I took a lamp and suddenly jarred several of the trees; when some of these worms came tumbling to the ground. The evidence against them would have been more conclusive, if I had searched the branches and found them there and at work. That however, I omitted to do. I have had fruit trees planted here sixteen years, but never had the buds destroyed so as to attract my attention before the last two years; nor have I had any complaints from my neighbors on this point, except during that time. Orchards are not very common here, but in three others in this town, I know young trees have been injured as in my own during the last two years. * * * I grow no dwarf apples; mine are all standard trees worked on the ordinary apple stock."

Mr. Cochran also found them last spring, up among the highest branches of his standard as well as his dwarf trees.

The subject is all important to the orchardist, and to those especially who have young and newly planted trees on a light soil; for there are many who have had their trees injured by the buds being devoured in this manner, who never dreamed of preventing such an occurrence, for the reason that the mischief was attributed to birds. Thus our Quail, Purple-finch, and many other birds, have too often unjustly received the execrations of the culturist, which that evil genius the cut-worm, alone deserved. To understand an enemy's foible is to have conquered, and when we learn the source of an evil it need exist no longer. The range of these climbing worms seems to be wide, for we have undoubted evidence of their attacking the grapevine, even in California, and I have found two species in Missouri, which have the same habit. Climbing cut-worms frequently have the same habit of severing plants, as those which have never been known to climb, and I very much incline to believe that this habit is only acquired in the spring time, and most cut-worms will mount trees if they are forced to do so, by the absence of herbaceous plants.

THE VARIEGATED CUT-WORM.—Pl. 1, Figs. 1, 2, 3 and 4.

(Larva of the Unarmed Rustic, *Agrotis inermis*, Harris.)

During the latter part of May, Mr. Isidor Bush, of Bushburg, Mo., brought me several greasy-looking worms, which had been feeding on, and doing considerable damage to a lot of young Creveling grapevines, which he had in cold frames. As I ascertained afterwards, upon visiting Mr. Bush's place, they lay concealed during the day, just under the surface of the rich earth, contained in the frames, and mounted the vines to feed, during the night time. The weather being warm, Mr. B. at my suggestion, threw open the frames during the day and allowed the chickens to get in them, and two days after doing this, there was not a worm to be found. By the 30th of May, these worms had grown to be of great size, measuring nigh two inches in length. When full grown they are mottled with dull flesh-color, brown and black, with elongated, velvety-black marks each side, as shown at Plate 1, Figure 2. The head is light gray and mottled, and marked as shown in Figure 3, and each segment on the back appears as in Figure 4 of the same plate.

About the time these worms were completing their growth, they having most likely developed earlier than usual, in the unnatural heat of the frames, I received from J. M. Shaffer, Secretary of the Iowa State Agricultural Society, some eggs which he found on a cherry twig. These eggs were quite small, of a pink color, with ribs radiating from a common centre, and were deposited in a batch. Exactly similar eggs, found on an apple twig, were presented to the Alton Horticultural Society, at its June meeting, by Mr. L. W. Lyon, of Bethalto, Ills.; while I subsequently found a batch of the very same eggs on a White mulberry LEAF, taken from a tree growing near St. Louis. Between the 24th and 30th of May, the young hatched from these eggs, in the shape of minute, thread-like worms of a dirty yellow color, and covered with the spots, already spoken of as occurring on all cut-worms, which are at this time in this species quite dark and conspicuous. In this early stage of their growth, they did not hide themselves in the ground, and had, furthermore, the peculiarity of looping up the back when in motion, in the same manner as does the Canker-worm, and as do all other geometers or span worms. After the first moult, which took place six days after hatching, the dark spots became almost obliterated, the characteristic markings of this same Variegated cut-worm which I had received from Mr. Bush, began to appear, and they lost their looping habit. At this time they grew at an incredible rate, becoming thicker in proportion to their length as they grew older, and by the 15th of June, those which hatched on the 24th of May, had shed their skins four times, and gone into the ground, where they formed oval cocoons of earth, and in two days more were changed into chrysalids. By the 20th of June the moths began issuing, thus requiring but 35 days to go through all their transformations.

These worms were very voracious, and after the first moult, showed the true cut-worm characteristic of concealing themselves during the day, and feeding at night. Moreover, they proved to be quite universal feeders, for while I fed them, when young, on cabbage and grapevine leaves, they flourished exceedingly, the latter part of their lives, on the leaves of the White mulberry; and on the 16th of June, I dug up from my garden, two full grown specimens of this same kind of worm, which produced the same species of moth, each of them having severed a young lettuce plant. From the foregoing, it is manifest that all cut-worm moths do not deposit their eggs on the ground, and from the fact that these eggs were found, in one instance, on a leaf, so early in the season, they were undoubtedly deposited in the spring by a moth which must have passed the winter either in the chrysalis or moth state; and as the insect goes through its transformations so rapidly, there are most likely two broods during the year. From the foregoing experience, and from the fact that most other moths attach their eggs to different substances, I think it not unlikely that our cut-worm moths do the same, as a general rule, instead of depositing them in, or on the ground, as has heretofore been supposed; and Mr. Cochran has related to me a curious incident which bears me out in this belief. He is in the habit of gathering, during the winter, all crumpled leaves and egg-masses which he finds in his orchard, and of placing them in a drawer in his secretary. Last spring he was astonished to find several half-grown cut-worms in this drawer, they having evidently hatched from some of the eggs, and fed entirely on some apples which chanced at that time to be in the drawer.

The moth produced from this cut-worm is represented at Plate 1, Figure 1. Its general color is a dark brownish-gray, some specimens being almost black along the front edge of the upper wings, while others have this edge of a dull golden-buff color. The NOCTUIDÆ, to which our cut-worm moths belong, have not yet been worked up by any one in this country, and as they are all of sombre colors, and as the species, in many instances, very closely resemble each other, it is not an easy matter to properly determine them. The species under consideration, is apparently quite common here, and yet Mr. A. Grote of New York, who made a trip to Europe last year, for the purpose of comparing our American moths with those in the British museum, and in other European collections, took a specimen with him and brought it back unnamed. In the collection of Mr. A. Bolter, of Chicago, it is marked *Agrotis saucia*, Treitschke, while Mr. Cresson informs me that in the collection of the American Entomological Society, at Philadelphia, it is named *æqua*, but without authority. Harris's description of *inermis* (Inj. Insects, p. 444), brief and insufficient as it is, agrees with some of the individuals, and, as it is said to be the counterpart of *æqua* which is an European species, I have concluded, rather than to create more synonyms, to redescribe it below, under this name. Individuals among the numerous specimens which I bred from the same batch of eggs, differ greatly from one another, and I find this to be the case with all owlet moths. Indeed, with the present species, a description taken from any single specimen would scarcely suffice for any of the others, and it is not at all unlikely that this species has received different names from different authors.

AGROTIS INERMIS, Harris—*Larva*—Length, when full grown, 2 inches. Finely mottled with dull, carneous-brown and black, and having dark velvety longitudinal marks along subdorsal and stigmatal region (see Pl. 1, Fig. 2); segment 11 somewhat ridged and abruptly divided transversely by velvety black and carneous. Lighter laterally than above. A carneous stripe below stigmata. Venter and legs speckled glaucous. Dorsum of segments marked as in Plate 1, Figure 4; Head light gray, and marked as in Plate 1, Figure 3. Cervical shield obselete.

Chrysalis.—Of normal form, deep mahogony brown, with a single point at extremity.

Perfect insect.—Average length 0.80; alar expanse 1.80. Ground color of fore wings gray-brown, marked as in Plate 1, Figure 1. A most variable species, sometimes washed with dull carneous, at others with light buff, but always marked with more or less smoky black. Costal region, head and thorax, sometimes very black, at others bright golden-buff. Spots usually lighter than wing, though sometimes concolorous. Basal half and transverse lines more or less distinct, especially at costa, geminate, their middle space, usually lighter than the ground color. Hind wings pearly white, with a very slight pink tint in the middle, shaded behind and veined with smoky brown.

Under surface of the wings, the least variable and most characteristic feature, that of fore-wings being mouse-gray with a distinct ferruginous spot in the middle at base, and a lighter strip running from this spot to the posterior angle; the arcuated band very distinct and geminate at costa, and the whole surface pearly and especially the light strip at interior margin, which in certain lights reflects all the prismatic colors. That of hind wings pearly white in the middle, darker near the margins, distinctly freckled along anterior margin, where the arcuated band is very distinct, while in the middle of the wing it is represented by distinct black strokes on the veins.

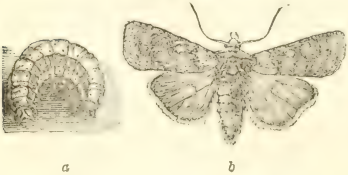
Described from 25 bred specimens.

THE DARK-SIDED CUT-WORM.

(Larva of the Cochran Rustic, *Agrotis Cochranii*, Riley.)

This worm is one of the most common of those which have the climbing habit. It is represented in the annexed Figure 26, at *a*.

[Fig. 26.]



The general color is dingy ash-gray, but it is characterized more especially by the sides being darker than the rest of the body. When young, it is much darker, and the white, which is below the dark lateral band, is then cream-colored, and very distinct. It produces a moth which may be known as the Cochran Rustic, and was first described in the *Prairie Farmer* of June 22, 1867. Speaking of the depredations of this worm, Mr Cochran says:

"In the beginning of the evening its activity is wonderful; moving along from limb to limb swiftly, and selecting at first only the blossom buds, to one of which having fastened, it does not let go its hold until the entire head is eaten out, and from this point, so thorough is its work, no latent or adventitious bud will ever again push. From a six-year old fruit tree, I have, on a single night, taken seventy-five of these worms, and, on the ensuing evening, found them well nigh as plenty on the same tree. When all the blossom buds of a tree are taken, it attacks with equal avidity the leaf buds. It is no unusual thing to find small trees with every bud that had pushed, from first intentions utterly destroyed, and frequently young orchards the first season planted on sandy grounds, lose from 50 to 75 per cent. of their trees; sometimes those remaining will be so badly injured as to linger along for a few years, fruiting prematurely each season, and then die, utterly drained of their vital principle by this dreadful enemy. The instinct of the perfect insect, like that of all insects injurious to vegetation, leads it unerringly to deposit its eggs where they will hatch out from the warmth of the sun, and where the larvæ is nearest to that food which is necessary to its existence: hence I never yet have found the eggs upon clay, or heavy cold grounds of any description, and on my carefully placing them in such situations they failed to hatch out. Can there be a stronger argument used for the appointment of a State Entomologist than the fact, that the habits of this enemy of horticulture, that has ruined millions of dollars worth of fruit trees in our country, has until recently been entirely unknown? I doubt whether one fruit grower in five hundred is even now aware of the presence of this curse on his grounds. There is not an orchard upon the sands of Michigan, or the light timber openings of Indiana, or the sandy ridges of our own State, but that has suffered greatly, many of them entirely ruined by its depredations. It is far more destructive to fruit trees than any other insect, infinitely more so than the canker worm, but unlike the other depredators of our orchard trees, it is easily kept in check, and at small expense permanently eradicated."

This species remains longer underground in the chrysalis state, than the preceding, and there is but one brood each year, the moths appearing through the months of July and August. The moth which is represented at Figure 26, *b*, is of a light warm gray color, and shaded with brown and umber.

Agrotis Cochranii, Riley—*Imago.*—Fore wings of a light warm cinereous, shaded with vandyke brown and umber, the terminal space, except at apex, being darker and smoky. Basal, middle and limbal areas of almost equal width, the middle exceeding somewhat the others. A geminate dark basal half-line, usually quite distinct. Transverse anterior geminate, dark, somewhat irregularly undulate, and slightly obliquing outwards from costa to interior margin. Transverse posterior geminate, the inner line being dark, distinct and regularly undulate between the nerves, while the outer line is plain and much paler; it is arcuated superiorly and inversely obliques for two-thirds its width. Orbicular and reniform spots of normal shape, having a fine, dark annulation, which is however obsolete in both, anteriorly; the orbicular is concolorous with the wing, whilst the reniform has a dark inner shade with a central light one, and forms with the transverse posterior a somewhat oval spot which is also dark. Median shade dark and distinct interiorly, shading off and becoming indistinct in center of wing, and quite dark between the two spots, giving them a fair relief. Subterminal line single, light, acutely and irregularly dentate, with an inner dark shade, but warmer than that of terminal space. Terminal line very fine, almost black, slightly undulate. Fringes of same color as wing, with a light central line, having an outer dark coincident shade. A dark costal spot in basal area; at termini of the usual lines, and two light ones in subterminal space. In some specimens one or two fine dark sagittate marks are discernable, and also a fine black claviform mark. Hind wings: whitish, with a darker shade along posterior margin. Under surface of fore wings somewhat lighter than the upper surface and pearlaceous interiorly, with a smoky arcuated band—more definite near the costa than elsewhere—and a tolerably distinct lunule. Under surface of hind wings concolorous; slightly irrorate with brown anteriorly and posteriorly, and with an indistinct lunule and band. Antennæ, prothorax, thorax, tegulæ and body of same color as primaries, the prothorax having a darker central line, and in common with the tegulæ a carneous margin. Under surface lighter; legs with the tarsi spotted.

This moth, in its general appearance, bears a great resemblance to *Hadena chenopodii*, but the two are found to differ essentially when compared. From specimens of *H. chenopodii*, kindly furnished me by Mr. Walsh, and named by Grote, I am enabled to give the essential differences, which are: 1st. In *A. Cochranii*, as already stated, the middle area exceeds somewhat in width either of the other two, while in *H. chenopodii* it is but half as wide as either. 2d. In the *Agrotis* the space between the spots and between the reniform and transverse posterior is dark, relieving the spots and giving them a light appearance, whilst in the *Hadena* this space is of the same color as the wing, and the reniform spot is dark. The claviform spot in the *Hadena* is also quite prominent, and one of its distinctive features, while in the *Agrotis* it is just about obsolete.

There are specimens that seem to be intermediate between these two, but all those bred by me, both male and female, were quite constant in their markings, and their intermediates will doubtless prove to be distinct species or mere varieties.

Larva—Length 1.07 inches. Slightly shagreened. General color, dingy ash-gray, with lighter or darker shadings. Dorsum light, inclining to flesh color, with a darker dingy line along its middle. The sides, particularly along the sub-dorsal line are of a darker shade. On each segment there are eight small, black, shiny, slightly elevated points, having the appearance of black sealing-wax, from each of which originates a small black bristle. The stigmata are of the same black color, and one of the black spots is placed quite close to them anteriorily. Head shiny and of the same dingy color as the body, with two darker marks, thick and almost joining at the upper surface, becoming thinner below and diverging toward the palpi. The upper surface of first segment is also shiny like the head. Ventral region of the same dingy color, but lighter, having a greenish tinge anteriorly and inclining to yellow under the anal segment. Legs of same color. It has a few short bristles on the anterior and posterior segments.

Chrysalis.—Length 0.70 of an inch. Light yellowish brown with a dusky line along top of abdomen. Joints, especially of the three segments immediately behind the wing-sheaths, dark brown. The brown part of these three segments, minutely punctured on the back. Eyes dark brown, and just above them, a smaller brownish spot. Two quite minute bristles at extremity.

Described from numerous bred specimens.

THE CLIMBING CUT-WORM—Pl. 1, Figs. 5, 6 and 7.

(Larva of the Climbing Rustic, *Agrotis scandens*, N. Sp.)

This is another of the most common species having the climbing habit. It occurs in at least five different States, for Mr. Walsh informs me that it is the species referred to by Mr. Townley, of Marquette county, Wisconsin, and I have found it with the same pernicious habit on Mr. Jordan's nursery at St. Louis, in our own State; while it was even more numerous, last spring, in North Illinois, North Indiana and West Michigan, than the preceding species, as I am informed by Mr. Cochran, and by Mr. H. D. Emery, of Chicago, who both sent me great numbers of specimens during the last week of April. The following interesting letter accompanied those which were received from the last named gentleman:

"I made a nocturnal visit to Mr. Cochran's place, Monday night, for the purpose of observing the workings of this pest, and spent about 3½ hours, until 1 o'clock in the morning, at the job. I found on some single dwarf trees over 50 at a time, and from that down, and they were on both apple, pear, peach and cherry. They commence ascending the trees soon after dark, and are found the most plenty from 11 to 12, some remaining on the trees until daylight, as I found several at 4 o'clock in the morning. Their first drive seems to be the terminal bud, and when these are all gone, they take side buds or even the bark of the tree in many cases, as you will see by the small twigs sent herein. You will see they are of different sizes. Some trees were entirely despoiled of the terminal buds. After they have eaten their fill, they seem to let themselves off the limb by a short web, and drop to the ground. We have found a large number of the worms attacked by the bug found in the tin box*. They would pierce the worm and suck him dry, and frequently two of them were hold of one worm. There were also numbers of spiders about the trees, of various sizes and kinds, all alive and alert, and apparently annoying if not preying upon the worms. Also a beetle, of which I send two specimens, was very active on the ground under the trees, apparently after prey †. The worms were the most abundant on the light sandy soils, and less frequent as the ground grew hard or clayey, and where it was pretty much all clay, scarcely one could be found. The tin tubes placed around the trunks of the trees, when properly adjusted, were a perfect protection. The injury they have already done is very great."

Mr. Cochran, speaking of the same worm, says: "Some trees were literally covered with them. Scarcely a bud but that had its worm, and, returning towards 10 o'clock, to those trees which we had in the early part of the night examined, we found others had come as abundantly as before. I have observed that they are actually ruining the young orchards along the Lake shore, and, strange as it may appear, their owners do not know what is doing the mischief. At Hyde park, where there are many handsome country residences with grounds of great beauty, this worm has been especially injurious to their young shrubbery."

This worm is represented at Plate 1, Figure 7. Its general color is a very light yellowish-gray, variegated with dirty bluish-green, and when filled with food it wears a much greener appearance than otherwise. In depth of shading it is variable however, and the young worm is of a more uniform dirty whitish-yellow, with the lines along the body less distinct but the shiny spots more so than in the full

* The bug was the Spined Soldier bug. (*Arma spinosa,* Dallas). See Figure 54.

† The Incrassated Geopinus (*Geopinus incrassatus,* Dej.) a beetle about ½ inch long and of the color and polished appearance of thin glue.

grown ones. Mr. Cochran informs me that on the apple tree, when this worm has fed out its bud, the work is so effectually done, that no adventitious or accessory bud ever starts again from the same place; the worm, as it were, boring into the very heart of the wood and effectually destroying the ability of the tree to react, at such a point, in the formation of a new bud, and that consequently a tree that is once stripped generally dies, and that this occurs more frequently on small or dwarf trees, where the buds are few, and 3 or 4 worms in a single night can eat out every one. But I have noticed that with the grape-vine this is not generally the case, as a new bud almost always appears where one has been eaten off.

Great numbers of these worms which I reared to the moth state, were fed promiscuously on apple and grape-vine leaves. They began entering the earth on the 20th of May, and generally issued as moths nine days after thus disappearing; the last moth having issued on the 29th of June.

The moth produced from this worm is easily distinguished from most other owlet moths by its peculiar color. It seems allied to *Agrotis cursoria* of Europe, and also greatly resembles one that was described as *A. murænula*, by Mr. Grote, and figured in Volume 1, Number 4, of the American Entomological Transactions. Upon submitting specimens to Mr. Grote, however, he informed me that it is distinct and undescribed, and I have therefore named it the Climbing rustic (*Agrotis scandens*). It is well represented with extended wings at Plate 1, Figure 5, and with closed wings at Figure 6. The general color of the upper wings is a pearly bluish-gray, while the under wings are pearly white; but as with the other species, it varies greatly in color and appearance, and as I could pick out, from 30 individuals, at least 4 which, if taken singly would doubtless be described as distinct species, it is not unlikely that Mr. Grote's *murænula*, may prove identical with it after all.

AGROTIS SCANDENS, N. Sp.—*Larva.*—Average length when full grown 1.40. Ground-color very light yellowish gray, variegated with glaucous in the shape of different sized patches, which are distinctly seen under the lens, to be separated by fine lines of the light ground color. A well defined dorsal and less distinct subdorsal and stigmatal line, caused by these patches becoming larger and darker; another and still less distinct line of the same kind under stigmata. The dorsal line frequently with a very fine white line along its middle, especially at sutures of segments. Piliferous spots in the normal position; those above black, those at the sides lighter. Stigmata black. Head and cervical shield tawny, the latter with a small black spot each side, the former with two in front, and two eye-spots each side. Caudal plate tawny, speckled with black. Venter and legs glaucous. Bristles fine and small. Filled with food it wears a much greener appearance than otherwise, while when young it is of a more uniform dirty whitish-yellow, the lines less distinct but the piliferous spots proportionately larger. Head quite variable in depth of shade.

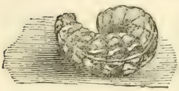
Perfect Insect.—Average length 0.70; alar expanse 1.50. General color of fore wings very light pearly bluish-gray, with a perceptible deepening posteriorly. Quite variable, sometimes of a more decided blue, at others inclining to buff as in *Leucania unipunctata*, Haw. Markings, when distinct, as in Plate 1, Figures 5 and 6. With the exception of the reniform spot and subterminal line, however, they are usually distinct only on costa, being either indistinct or entirely obsolete on the rest of the wing. The subterminal line is light, with a more or less dark diffuse shade each side, which, in some instances, forms into sagittate spots. A black stain at the lower part of reniform spot forms a most distinctive character. Hind wings very pale and lacking the bluish cast of fore wings; lunule distinct, and a dark shade, enclosing a lighter mark, as in *Heliothis*, along posterior margin. Eyes dark; head and thorax same as fore wings; abdomen same as hind wings. The whole under surface the same as hind wings above, the lunules and arcuated bands faintly traced, the fore wings having a darker shade in the middle.

Described from 30 bred specimens.

THE W-MARKED CUT-WORM.—Pl. 1, Fig. 13.
(Larva of the Clandestine Owlet moth, *Noctua clandestina*, Harris.)

Another cut-worm which has this same habit of climbing trees, I have named the W-marked cut-worm, on account of the characteristic markings resembling this letter, which it has on its back. Its general color is ash-gray, inclining on the back and upper sides to dirty yellow, and the annexed Figure 27 gives a correct view of it. This species, so far as I have observed, though it has been caught in the act of eating apple buds, is but seldom found very high up on trees, but seems to prefer to attack low bushes, such as currants, on which I have often found it. It occurs abundantly on a species of wild endive (probably *Cichorium sativa*), under the broad leaves of which it frequently nestles during the day, without entering into the ground. Harris quotes a communication from Dr. F. E. Melsheimer, of Dover, Pa., in which this same worm is said to attack young corn, and to feed indiscriminately on all succulent plants, such as early sown buckwheat, young pumpkin-plants, young beans, cabbage plants, and many other field and garden vegetables. Mr. Glover, of the Department of Agriculture, has also found it to attack wheat, and I have found it quite injurious to young cabbages. In feeding, it frequently drags its food under stones and other places of concealment. The young worms are of a more decided gray than the older ones, with the black W-shaped marks less distinct, and subsist, for the most part, on grasses.

[Fig. 27.]



The moth produced from this worm is illustrated at Plate 1, Figure 13. It appears during the latter part of June, and is, consequently, one of our earliest. It is of a dark ash-gray color, with the wavy bands but faintly traced. The two ordinary spots are small, narrow, and usually connected by a fine black line. The hind wings are dirty brownish-white, somewhat darker behind. It may be popularly known as the Clandestine Owlet moth, and was named *Noctua clandestina*, by Harris, though it might be placed with more propriety in the genus *Graphiphora*.

NOCTUA CLANDESTINA, Harris.—*Larva*—Length, when full grown, 1.15 of an inch. General color ash-gray, inclining on the back and upper sides to dirty yellow. Finely speckled all over with black and brown spots. Along the dorsum there is a fine line of a lighter color, shaded on each side, at the ring joints with a darker color. Sub-dorsal line light sulphur-yellow, with a band of dirty brownish-yellow underneath. Along the stigmatal region is a wavy line of a dark shade, with flesh-colored markings underneath it; but the distinguishing feature is a row of black velvety marks along each side of the back, on all but the thoracic segments, and bearing a general resemblance, looking from anus to head, to the letter W. Ventral region greenish-gray; prolegs of same color; thoracic legs brown-black. Head black, with a white line in front resembling an inverted Y, and white at sides. The thoracic segments frequently have a greenish hue.

Chrysalis.—Of the normal form and color, with but one rather long thorn at extremity.

THE GREASY CUT-WORM.—Pl. 1, Figs. 8, 9 and 10.
(Larva of the Lance Rustic, *Agrotis telifera*, Harris.)

In the *Prairie Farmer* for June 22, 1867, I described a large cut-worm under the name of the "Black cut-worm." I have since ascertained that it is quite variable in its coloration, some specimens being lighter, and the markings much more distinct than in others, and have therefore concluded to give it the above appellation. This worm is usually of a deep leaden-brown inclining to black, though some specimens are of a greasy glaucous color, with a dark flesh-colored back. It is always more or less distinctly marked as in Figure 9, of Plate 1, while the head, when retracted within the first segment, presents the appearance of Figure 10 on the same plate, this figure being enlarged beyond the natural size. It is probably the most common cut-worm in the country, for the moth is frequently caught in our rooms in all parts of the United States. Though it has not, so far as I am aware, the climbing habit of the preceding species, it has a most emphatic and pernicious *cutting* habit.

Mr. Jordan, of the St. Louis nursery, had transplanted a great number of tomato plants last spring, but lost well-nigh every one of them by this pernicious worm. It cut off large plants that were over six inches in height, generally at about an inch above ground, and thus effectually destroyed them. After severing one plant, the same worm would travel to others, and thus in a single night, from three to four plants would be ruined by a single individual. Along the Clayton road, to the west of St. Louis, most of the corn had to be replanted on account of its attacks. On the 22d of May I examined several fields, and was surprised to find these worms present at almost every hill, most of them being two-thirds grown. The land is clayey, and was at that time quite hard, and each worm had a smooth burrow in which it lay hidden, and to the bottom of which it could generally be traced. I subsequently learned that a large tobacco field belonging to Mr. F. R. Allen, of Allenton, had been entirely ruined soon after it was planted, by this same worm, and I found it in my own garden cutting off cypress vines. Indeed, nothing seems to come amiss to its voracious appetite, for in confinement it devoured with equal relish, apple and grape leaves.

This species comes to its growth in this latitude by the end of May, though the moth does not make its appearance till the month of July.

The moth is known as the Lance Rustic (*Agrotis telifera*, Harris), and is represented in the annexed Figure 28, and still more correctly at Plate 1, Figure 8. The upper wings are light-brown shaded with dark-brown, and the under wings are pearly white, with a gray shade around the edges; but the characteristic feature, from which it takes its name, is a dark-brown lance-shaped mark running outwardly from the kidney-spot.

[Fig. 28.]

AGROTIS TELIFERA, Harris—*Larva*—(Pl. 1, Fig. 9)—Length 1.50@1.60 inches when crawling. General color above, dull dark leaden-brown. A faint trace of a dirty yellow-white line along dorsum. Subdorsal line more distinct, and between it and stigmata two other indistinct pale lines. Eight black shiny piliferous spots on each segment; two near subdorsal line, the smaller a little above anteriorly; the larger just below it, a little back of the middle of the segment, with the line appearing especially light above it. The other two are placed each side of stigmata, the one anteriorly a little above, the other just behind, in the same line with them, and having a white shade above it. Head light brown, with a dark brown spot each side and dark brown above, leaving the inverted Y mark in the middle, light brown, and having much the appearance of a goblet, as one looks from tail to head. Cervical shield dark brown, except a stripe above and each side. Sparse short white bristles laterally and posteriorly. Venter and pro-legs of a glaucous glassy color. Thoracic legs light brown.

It varies considerably in depth of shading, and some of the lighter specimens have the lateral stripes quite distinct, and the dorsum is frequently of a dull carneous with a darker shade, divided by a fine line of a lighter color, along the middle. There is frequently a third piliferous spot near the stigmata.

Chrysalis.—Average length 0.54 of an inch, very pale shiny yellowish-brown, with two large dark brown eye-spots. Stigmata and anterior edge of four largest abdominal segments on the back, also dark brown and shagreened. Two minute thorns at extremity.

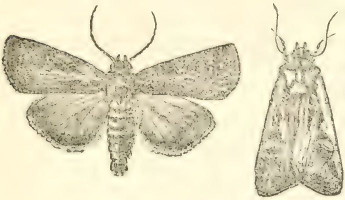
Imago.—As Harris's description, as given in his "Injurious Insects," is not very complete, I subjoin a more detailed one: Average expanse 1.60 inches. Color of fore-wings brownish-gray, verging into a very dark brown, with a bluish tint at the costa, for nearly one-third the width of the wing. Middle area somewhat darker than basal and limbal, the latter being especially light at the apex, and between transverse posterior and subterminal lines; having distinct spots on the nerves, and two distinct sagittate marks. Ordinary spots dark, with a very fine dark brown annulation, especially distinct around the dentiform. Reniform spot of normal shape. Orbicular nearly oval, and generally elongated into a point posteriorly. Distinguishing feature a dark brown lance-shaped mark, running from posterior portion of reniform spot. Transverse anterior geminate, dark. T. posterior geminate, dark, projected and arcuated above. Subterminal line light, irregular and festooned. Median band distinct. Subterminal space dark, especially where broadest, at nerves 5, 6 and 7. Margins dark brown, with a lighter inward, angular rim between each nerve. Costa with usual spots. Fringes light, with a central line, the inner half having dark square spots on the nerves. Hind wings pearly white, semi-transparent, margined behind and veined with dusky gray. Fringes even whiter, with a faint darker line. Under side of fore wings pearly-gray; hind wings concolorous, but with a broad band of speckled gray on the anterior margin. Legs dark, with light spots at joints. Head often rust-brown. Antennæ brownish. Prothorax very clearly defined, and of a rich dark brown at margins. Thorax and body light lilaceous-gray, the tegulæ being rimmed with flesh color.

THE WESTERN STRIPED CUT-WORM.

(Larva of the Gothic Dart, *Agrotis subgothica*, Haworth).

Dr. Fitch, in his Second Report, on noxious insects of the State of New York, describes a cut-worm by the name of the "Striped cut-worm," (p. 313). In his 9th Report, (pp. 245–8), this worm was very fully re-described, together with the moth which it produces. This worm seems to have done great injury to the corn crop in the East, and the moth is a variety of the Corn Rustic (*Agrotis nigricans*, Linn,) which Dr. Fitch named *maizi*. It will be referred to on page 87. From worms, found in an orchard, and answering entirely to that description, I have bred numerous specimens of one of our most common owlet moths, namely, the Gothic Dart (*Agrotis subgothica*, Haworth). As the worms are so similar in appearance, I have called the one under consideration, the "Western Striped Cut-worm," as no other name would better characterize it, though it is evidently as common in the East as it is in the West. Its general appearance is not greatly unlike that of the "Greasy Cut-worm" already described, but its average size is but 1¼ inches. The ground color is dirty white or ash-gray and it has three broad dark lines, and two light narrow ones along the sides, and a light one, edged on each side with a dark one, along the middle of the back. This species remains longer in the ground than any of the others, and the moth does not appear till August and September. The moth is represented at Figure 29, *a*, with the wings expanded, and at *b* with the wings closed. Its markings are so conspicuous and characteristic that it suffices to say that the light parts are of grayish flesh-color, and the dark parts of a deep brown. It was first described in the year 1810 by Mr. Haworth, and is supposed to be an English insect; but as it is quite rare in England, and very common in this country, Dr. Fitch concludes, and I think rightly, that it is an American insect, the eggs or larvæ of which have accidentally been carried to England.

[Fig. 29.]



a *b*

AGROTIS SUBGOTHICA, HAW.—*Larva.*—Length 1.25 inches. Ground color dirty white or ash-gray, inclining in some instances to yellowish. A whitish dorsal line edged on each side with a dark one. Three lateral dark broader stripes—the lower one broadest of all—separated by two pale ones. Quite often an indistinct glaucous white stripe under the lower broad dark one. Piliferous spots of good size. Head shiny black, or in some individuals finely speckled with white, especially at the sides; with the usual forked white line like an inverted Y. Cervical shield, or upper portion of the first segment, of the same shiny color as the head, with a white stripe in the middle, contiguous to that on the head, and another each side. Venter dull white. Legs the same, varied with smoky brown.

THE DINGY CUT-WORM—Pl. 1, Fig. 11.

(Larva of the Dart-bearing Rustic, *Agrotis jaculifera.*)

We have, in the West, another cut-worm, resembling the preceding species in almost every particular, the following being the only permanent differences: 1st, It never attains quite so large a size, 2d, it is generally darker and more dingy, and the longitudinal lines are consequently less distinct; 3d, it is generally of a more decided dull pale buff color on the back.

On the 27th of last June, I received several of these cut-worms from Mr. Horace Starkey, of Rockford, Illinois, with a statement that they were proving quite destructive in the gardens of that vicinity, but without specifying what particular plants they attacked. They entered the ground soon after being received, and by the 7th of July, had all changed to chrysalids. The chrysalis differs from most of the others, in being of a very light honey-yellow, shaded with brown, with the eyes dark brown, and two sub quadrate spots of the same color on the wing-sheaths, just above the antennæ. It measures 0.65 of an inch in length. The moths began to issue on the 2d of September, and proved to be a species very closely allied to the preceding. Indeed the markings on the wings are almost exactly the same; but it is a smaller species, seldom expanding more than 1.25 inches and differs materially upon a strict comparison, and especially in the ground color being lighter and more silvery. It is faithfully represented at Plate 1, Figure 11. This species, as I am kindly informed by Mr. Cresson, is marked *Agrotis jaculifera* in the collection of the American Entomological Society, but without authorship; and as the name seems appropriate I have retained it.

Thus we have in this country, at least three species of cut-worms, which differ no more from one another in general appearance, than do individuals of the same species; and yet they all produce distinct moths, though it is worthy of remark that the moths produced from worms so resembling each other, viz: *Agrotis nigricans*, var *maizi*, *A. subgothica* and *A jaculifera*; have, all three of them, the space between and behind the two ordinary spots on the front wings of a dark brown color. It is possible that each of these species may have a different habit, but time, and further investigation will alone determine the point.

AGROTIS JACULIFERA—*Larva*—Length one inch. Similarly marked to that of *Agrotis subgothica*, with the colors darker and more dingy, the longitudinal lines less conspicuous, and the dorsum of a more decided pale buff color.

Chrysalis—Length 0.65–0.70. Color honey-yellow with dull brown shadings, and dark-brown eyes, but characterized especially by two subquadrate dark spots on the wing-sheaths just above antennæ.

Perfect insect—Much resembling *A, subgothica*, Haw., being marked as at Plate 1, Figure 11. It differs from that species in the following respects: The average expanse is but 1.30. The whole ground-color is colder (to use the language of the artist), i. e., of a whiter gray, with less of the buff color. The costa is darker, and the light costal band narrower; the posterior median nerve is almost white and very distinct to the lower part of the reniform spot; nerves 3, 4 and 5 are well relieved by light margins; the streak running between nerves 2 and 3 is very distinct and less diffuse; the terminal space is darker, and the inner margin only broken by nerves 4 and 5; there are no sagittate spots, while the posterior margin is very clearly defined by a black line bounded outwardly by a light one.

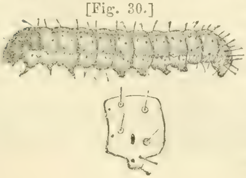
Described from three bred specimens.

THE GLASSY CUT-WORM.

(Larva of the Devastating Dart, *Agrotis devastator*, Brace.)

In the year 1819, in a short article upon the cut-worm, published in the first volume of Silliman's Journal, p. 157, Mr. Brace, of Litchfield, Connecticut, gave an account of this moth, which he bred from pupæ that were found a few inches under the ground, in a cabbage patch. He did not describe the worm which produced the pupæ, as he evidently supposed there was but one kind of cut-worm in existence. Consequently, up to the present day the larva of this common Devastating Dart moth has been unknown. It was my good fortune to breed this moth from the larva state. The cut-worm from which it

[Fig. 30.]



was produced, was found on the 12th of May under a wild endive plant, upon the leaves of which it had evidently been feeding. It was but half grown, and, being placed in a jar half filled with earth, that contained growing grass, it burrowed into the earth and after once casting its skin, fed entirely on the roots of the grass, though other food was thrown into the jar. On the 7th of June it measured 1.80 inches when crawling, and on the 19th of the same month had changed to a chrysalis from which the moth emerged on the 7th of July. The worm is represented at Figure 30, and may at once be distinguished from all others of its tribe, that are known, by its translucent glassy green body, in contrast with a very distinct hard, polished, dark-brown shield on the first segment, and a bright venetian-red head. The usual spots on the body are quite distinct, and placed in the positions given at the lower outline of Figure 30, which represents the side of one of the middle segments.

The moth bears a close general resemblance to the Cochran Rustic already described, the ground color being the same. It differs in its larger size; in the wavy transverse lines being more equidistant; in the spots in the shape of arrow heads, which emanate from the inside of the last or outer line, being darker and more distinct; and in the outer edge of the large kidney-shaped spot being almost always quite white. Entomologically, it differs still more essentially, for though named *Agrotis devastator*, it seems to belong to the genus *Mamestra*. Here we have the converse of the facts given, in speaking of the Dingy cut-worm, for, closely as the Cochran Rustic and this Devastating Dart moth resembles each other, their larvæ are very dissimilar.

AGROTIS (MAMESTRA) DEVASTATOR, Brace—*Larva.*—Length 1.80. Color translucent glassy green, with a tinge of blue. Usually, a very deep bluish dorsal line. Four distinct piliferous spots on each segment, each with a slight annulation. Two other minute simple spots, without hairs on the anterior edge of the segment (see Fig. 30,). Head, bright Venetian-red, with black jaws, and a small black spot each side. Cervical shield, very distinct, hard, polished and of a dark brown. Caudal plate, less defined and more dusky. The body is lighter posteriorly than anteriorly and the dorsal line is most distinct along the middle segments.

Chrysalis—Quite dark mahogany brown, with the body somewhat more attenuated than is usual, and with two distinct slightly curved thorns at extremity with several other stiff bristles around them.

THE SPECKLED CUT-WORM—Pl. 1, Figs. 14, 15, 16 and 17.
(Larva of the Subjoined Hadena, *Hadena subjuncta,* Gr. & Rob.)

At two different times, I have found in a truck garden hiding in the ground, under cabbage plants, near St. Louis, a cut worm which may be known by the above name. On one occasion, I also received the same worm from my friend, Mr. A. Bolter, of Chicago, who found it in Wisconsin. It is at once distinguished from all others that are known by several characteristics, but more especially by being speckled as with pepper and salt, when viewed with a pocket lens, the ground color being flesh-gray, with a tinge of rust color in the middle of each segment. The head is marked as in Figure 15, each segment on the back as in Figure 16, and the extremity as in Figure 17 of Plate 1—these figures being enlarged the better to show the markings.

Those which I bred, fed voraciously on cabbage leaves during the night and lay concealed and motionless during the day. Before changing to chrysalids, they became of a uniform pale dirty yellow, with the markings almost entirely obliterated. The chrysalis is of the usual form and the moths appeared between the 2d and 8th of August. The kind of moth that was produced from these worms is faithfully represented at Plate 1, Figure 14, the front wings being marked as in the figure, with grayish-brown and black, and having a dull flesh-colored shade. It differs essentially from all those that I have hitherto described, and belongs to a different genus (*Hadena*). It was named *Hadena subjuncta* by Guénée, in his MS. and this name has been retained by Messrs. Grote & Robinson, in their description of it published in the Transactions of the American Entomological Society, Volume II, pp. 198–9, which will be found below.

HADENA SUBJUNCTA, Gr. & Rob.—*Larva.*—Average length 1.60 inches. Color carneous-gray, inclining to ferruginous in the middle of each segment. Minutely speckled as with pepper and salt. A lateral stigmatal stripe, somewhat lighter than the rest of the body. An interrupted dorsal and subdorsal white line, these lines being quite distinct on the posterior half and indistinct on the anterior half of each segment. Two distinct spots anteriorly on the dorsum of each segment; the other spots obsolete. Head light shiny brown, with two outwardly diverging darker marks. Segment 1, with the three longitudinal white lines and a white anterior edge, shaded on the inside with dark brown. Anal segment with a white transverse line, somewhat in the shape of a drawn-out W, and with a deep shade above it. Venter glaucous. Legs of the same color.

Chrysalis.—Of a deep brown color, rather short and thick, and with two bristles at extremity.

Imago—(Pl. 1, fig. 14). Length 0.65; expanse 1.50. ♂ ♀.—Antennæ simple, finely and shortly ciliate beneath. Carneous brown. Head with a dark frontal line. Prothoracic pieces with a very distinct and deep brown line. Abdomen crested above at base, with a spreading anal tuft in the male. Fore wings, above, blackish brown shaded with carneous. A longitudinal deep brown basal ray, shaded inferiorly, extending outwardly and narrowly to the transverse anterior line. Above this ray, the base is tinged with carneous, and the basal line is indicated by a dark geminate costal streak. Transverse anterior line geminate, the outer line the darker, roundedly and evenly interspaceally waved, nearly prependicular. Ordinary spots very large, distinctly limited. The median space is wide superiorly, but is constricted below the median nervure; a longitudinal deep brown streak runs along the submedian fold and connects the two median lines at their point of greatest contiguity. This streak becomes the lower margin of the claviform spot which abutts from the transverse anterior line, and whose upper margin is seen in a very distinct deep brown line running outwardly and downwardly obliquely from the median nervure. Above the claviform is the large obicular, pale, with a distinct annulus. The reniform is wide, of the ordinary shape, with an indistinct central shade and the distinct annulus is often obsolete outwardly. Beyond the reniform, the wing is shaded with carneous to the subterminal line, this shade spreading inferiorly. A diffuse and faint blackish median shade runs from the costa downward between the ordinary spots and is discontinued below median nervure. The transverse posterior line is incepted above the reniform, runs outwardly straightly along the costal region, thence downwardly over the nervules, bending inwardly beneath the reniform spot. It is geminate, faint, the lines enclosing a paler space and interspaceally lunulate. Subterminal line pale, preceded by a dark shade, forming the usual M-shaped mark at the middle, the points of the M attaining the external margin. The dark shading is sometimes tinged with olivaceous before the internal angle as is the inferior shading of the longitudinal streak connecting the median lines. The terminal space is blackish brown and black interspaceal marks precede the terminal line. The fringes are uneven; the external margin of the wing retires inwardly before internal angle.

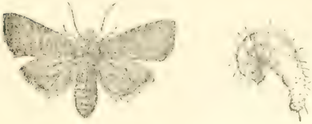
Hind wings smoky blackish, paler towards the base, without discernable discal mark or lines. Under surface pale. The wings terminally and along costal edges are covered with powdery squamation with intermixed dark scales bringing the nervules into relief. The fore wings show three ante-apical white dots and the white subterminal shade line emanates from a fourth and larger dot just before the apex, these latter at times hardly discernable. Faint discal dots; *sometimes traces* of dark median lines can be seen on both wings.

THE SMALL WHITE BRISTLY CUT-WORM.

(Larva of the Figure 8 Minor, *Celæna renigera*, Stephens).

During the month of August in North Illinois, a small dirty-white cut-worm may frequently be found in flower gardens, where it doubtless feeds for the most part on the roots of various flowers. This worm is represented at Figure 31 *b*. It never gets to be more than ¾ of an inch in length, and is covered with distinct, stiff yellow bristles, and may be popularly known by the above name. During the fore part of August it descends deeper into the ground, and soon changes to a very bright shiny, mahogany brown chrysalis, from which in about three weeks afterwards, the moth emerges.

[Fig. 31.]



a b

This moth is represented (as well as a wood cut can represent it) at Figure 31 *a*. It is quite prettily marked, the fore-wings being brown, variegated with lilac-gray and moss-green, with a deep brown spot about the middle and a silvery annulation around the kidney-shaped spot. It is the *Celæna renigera* of Stephens of which *C. herbimacula*, Guénée is a synonym, and as it should have a popular name, it may be called the "Figure 8 Minor," in allusion to the silvery edge of the kidney-spot which almost always reminds one of the figure 8. In the genus *Celæna* the wings are entire, broad and rounded, and there is a conspicuous tuft on the crown of the head. The species may at once be distinguished from those of *Agrotis* and *Hadena* by their smaller size and more rounded appearance.

CELÆNA RENIGERA, Stephens.—*Larva.*—Length 0.75 of an inch.—Color dusky salmon-yellow, the dusky dirty appearance, caused by innumerable dark specks all over it. Largest at the four middle segments and tapering thence each way. A dark lateral stripe, distinct on the middle segments, indistinct at both ends. Distinguishing feature, very visible stiff yellowish bristles, proceeding from the usual spots which are small. A dorsal line is indicated under the glass by two indistinct thin lines at the joints of the segments.

Chrysalis.—Length 0.56 of an inch; concise; of a bright polished mahogany brown, with dark eyes and very slightly punctured on the anterior portion of the abdominal segments.

Imago.—Expanse 1.10 inches. Fore wings brownish-gray, with a more or less determined carneous or lilaceous hue. Orbicular spot sub-obsolete; sometimes entirely obsolete. Reniform spot of normal shape, moss-green, with a snow-white annulation, indistinct above, broad and distinct below. Ordinary lines lighter. Basal half-line distinct only on costa, and below posterior median nerve. Transverse anterior single, obliquing but slightly, and bordered posteriorly with a very thin broken darker line; it is moss-green in the middle, and there is a green shade running from it to the basal half-line, dividing the sub-basal space. Opposite this green in the median space, is a dark subquadrate almost black spot, and between the stigma the wings are also quite dark. Transverse posterior single, posteriorly oblique a little more than ⅓ of breadth of wing, then parallel with posterior margin, forming at the second nerve a roundish spot which extends to the anal angle, and is dark below and moss-green above. Subterminal line usually very indistinct—merely indicated by a few dots. A median arcuated band is perceptible, being broader and darker between the stigma and interrupted in the middle by lower portion of reniform spot. A minute light spot on each vein at posterior margin. Costa with a light spot at terminus of sub-basal line, of transverse anterior, and above reniform spots—dark each side of these and at terminus of median band; concolorous with wing at subterminal space, having four very minute light spots, one at ends of subterminal and transverse posterior lines, and two between them. Fringes concolorous with the wing, having a very fine darker edge.

Hind wings carneous-gray at base and interiorly—darker anteriorly and posteriorly and especially at posterior margin. Nerves and lunule rather dark. Fringes same color as interior of wing, with a darker central line.

Under surface of fore wings brownish-gray, the fringes and transverse posterior darker and the spots faintly marked at costa. Under surface of hind wings of same color above, lighter below, with the lunule dark and the arcuated band distinct.

Legs dark-gray with light spots at joints ; palpi same color. Head, prothorax and thorax not quite so purplish as wings. Prothorax with a light margin at junction of wings—the tegulæ also with a light spot. Body same color as hind wings above, darker below. Feelers same.

OTHER CUT-WORMS.

Besides the ten distinct cut-worms, whose transformations I have just recorded, there are two others, which Dr. Fitch has described in all their stages. The one is the "STRIPED" or "CORN CUT WORM" as he calls it, which proves very injurious to corn, by cutting it off about an inch *above* ground. This worm produces a dusky-gray moth (*Agrotis nigricans*, Linn.—var. *maizi*), which is distinguished principally by two coal black spots, one nearly square, placed outside of the centre of the fore wing, and the other nearly triangular, a little forward of it, a roundish nearly white spot separating them. The other which Dr. Fitch has called the "YELLOW-HEADED CUT-WORM," is of a shining livid color, with a yellowish or chestnut-colored head and a horny spot of the same color on the top of the first and last rings. It is a large species and produces the Amputating Brocade moth (*Hadena amputatrix*, Fitch), which is figured on page 450, of Harris' work. This moth is distinguished by its Spanish-brown upper wings, marked with a large pale kidney-shaped spot, and a broad wavy blue-gray band near the end. The worm was found by Dr. Fitch to be even more injurious to corn than the striped species, since it severs the plant *below* ground ; while it also combines the habit of climbing trees during the night, according to Harris.

Thus, we are now acquainted with the natural history of just one dozen of these cut-worms, while there is fully another dozen whose habits and history yet remain to be studied. Of one of these, especial- soon to give the complete history. Meanwhile, I will give a brief account of the worm itself, which may be known as

THE WHEAT CUT-WORM.

On the 10th of October, 1868, I received from Mr. F. R. Allen, of Allenton, Missouri, the following communication:

"Enclosed I send you some specimens of a worm that seems to be preying upon the recently sown wheat. My neighbor, Mr. George W. Moore, informed me a day or two ago, that a worm was eating all his wheat that he had lately sown in oats ground. I went to see what it was yesterday, and as I am not entomologist enough to tell, I refer them to you. Mr. Moore has learned within a day or two, that this same insect is now generally preying on the wheat in Franklin county, that is sown on oats stubble. What is remarkable they do not yet trouble the wheat in the same field sown on wheat stubble. Nor do they seem to feed on the volunteer oats in the same field, but entirely destroy the young wheat."

Subsequently, upon visiting Allenton, Eureka, and other places in St. Louis county, I ascertained from L. D. Votaw and others, that this worm had been known to attack wheat in the fall for many years back. They come to their growth the latter part of October, descend into the earth and pass the winter in the chrysalis state. The only manner in which I can account for their appearing only on that wheat which was sown on oats stubble, is by supposing that the scattering oats that were left after harvest had sprouted before the wheat, and had thus attracted the parent moths. On this supposition the worms had hatched and fed awhile, before the ground was ploughed, and planted to fall wheat, and this seems the more likely, since the worms were full-grown, almost as soon as the wheat appeared above ground. If this supposition be correct, the attacks of this worm can be effectually prevented by ploughing the land early and keeping the ground clear of all vegetation until the wheat is planted. No other rational explanation can be given, for I found by experiment that they would devour with equal relish the young plants of both oats, wheat, and a variety of grasses.

In the *Canada Farmer* for April 15, 1867, an account was given of the ravages of "cut-worms" on Spring wheat, in the county of Huron. Judging from the account however, the worm referred to, was the common "White grub;" but if it be the same as that spoken of above, the fact can be ascertained by the description which I subjoin herewith.

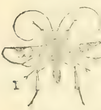
THE WHEAT CUT-WORM.—A dark pitchy black cut-worm, the characteristic mark being, a very distinct pale buff or flesh-colored stigmatal band. Dorsum generally of a brownish shade, the dorsal line of the same color, with a more or less distinct dingy shade each side of it. The subdorsal region is always the darkest part of the worm, being of a pitchy brown; but edged above, at junction of dorsum, with a fine light buff-colored line, and generally variegated in the middle, with very minute light colored irrorations. Eight sealing-wax-like black elevated piliferous spots on each segment, those on dorsum usually having a white base outwardly. Greatest width at segments 10 and 11, the spots upon them being also the largest. Head, deep polished brown, with the usual inverted Y-shaped white mark, and some white spots at sides; also with white lips, and perfectly white palpi. Cervical shield, of same color as dorsum, but polished, and with the dorsal and sub-dorsal white lines quite distinct upon it. Caudal plate with a bright cream-colored longitudinal dash (generally constricted in the middle) between two black spots. Venter and legs glassy glaucous. The young worm is almost uniformly pitchy black, with the light stigmatal band always visible however. Indeed this band is always constant no matter how much the worms vary in depth of ground-color.

There are various other naked caterpillars which are frequently found upon the ground near vegetation of various kinds. Thus during the months of July and August, a species with the back of each segment very characteristically marked as represented at Plate 1, Figure 12, may often be found. It seems to feed on a variety of herbs, and produces a prettily variegated moth known as *Prodenia commelinæ*, Guénée; but though this and other species may have the cutting habit, they have never attracted notice so far, and I shall pass them over and proceed at once to suggest the proper preventives and

REMEDIES AGAINST CUT WORMS.

NATURAL REMEDIES.—These cut-worms, like all other vegetable-feeding insects, have numerous insect enemies which are continually on the alert for them, and materially assist us in keeping them in due bounds. Of those that are parasitic internally may be mentioned the minute four-winged flies belonging to the genus *Microgaster*. One of these which is parasitic on the Army-worm (the *M. militaris* of Walsh) is represented at Figure 32, and it bears a strong resemblance to an undescribed species which I have often bred from a cut-worm, described in the *Prairie Farmer* as the "Pale cut-worm." The female fly punctures the tender skin of the worm and deposits great numbers of eggs in the body. These eggs produce maggots which live upon the fatty parts of the worm, and slowly but surely produce the death of their victim. When full grown they pierce the skin of the worm and spin their white silken cocoons, in company, on his body, and in due time issue forth as flies.

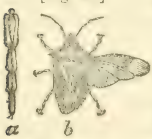
[Fig. 32.]



There is also a large yellowish-brown four-winged Ichneumon fly (the *Paniscus geminatus* of Say), which I have bred from cut worms. The parent fly deposits a single egg within the body of a worm, but the maggot hatching from this egg does not cause the worm to die, till after the latter has entered the earth to become a chrysalis. At this point the worm suddenly succumbs and the maggot spins a tough, black, smooth cocoon, and where we expected to see a moth rise to day-light, we behold in time this Ichneumon fly.

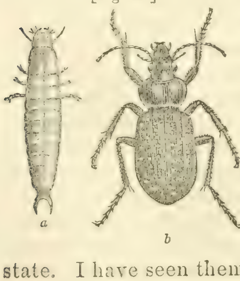
Among the cannibals, that bodily devour these worms, may be mentioned the Spined Soldier-bug, already referred to on page 77, note, and whose likeness I produce at Figure 33. This fellow is such a thorough cannibal, and so serviceable to man, that his portrait cannot be too well graven on the mind. It is not unlikely, also, that most of the ground beetles that are figured in a future chapter on the 10-lined Potato beetle, prey upon cut-worms; and the Homely Geopinus referred to in the note on page 77 has been found to do so, but by far the most efficient insect in slaying these worms is the larva of the Fiery Ground beetle (*Calosoma calidum*, Fabr.), which I represent at Figure 34 *a*, by the side of its parent Figure 34 *b*. This larva has very appropriately been called the Cut-worm lion, by Dr. Shimer of Mt. Carroll, Illinois, who gives the following account of its mode of transformation to the perfect beetle: "The fat, full grown larva of *Calosoma calidum* chooses a hard piece of ground, as a wagon road in the field, where it bores into to pass the pupa state. I have seen them many hours in boring a few inches. These

[Fig. 33.]



a *b*

[Fig. 34.]



a *b*

fierce insects often wage terrible battles when they encounter each other, and they will eat each other as readily as cut-worms, as I found whenever I put more than one of them into my collecting box. He that would breed these insects to the perfect state, must pack the dirt in his breeding box as hard as a wagon road, or he will fail, as I always did before I saw their operations in the field. In using moderately compact earth, the larva digs it over and over, endeavoring to find a suitably dense place, works up the dirt into balls, until its feet are clogged up with earth and juices from its mouth, and it sinks exhausted and dies. In a few days after it enters the ground, the beautiful spotted, perfect beetle appears, and, strangely, the smell of the beetle is peculiar and entirely different from the larva."

This Cut-worm lion has quite a formidable appearance, and is exceedingly agile. It is flattened, of a black color, with six legs upon the breast, and a pair of sharp hook-like jaws projecting in front of its head. It pursues the worms in their retreats under the ground, and seizes them wherever it comes in contact with them. Sometimes a young Cut-worm lion will seize a worm twice as large as itself, and will cling with bull dog tenacity to its prey, through all its throes, its writhings and twistings, till at last the worm succumbs, exhausted, and the victor bites two or three holes through its skin and proceeds to suck out its juices.

Some kinds of spiders are also known to prey on cut-worms, and these unwisely unpopular little animals should always be cherished and protected. Poultry is also quite efficient in destroying them, and chickens are better than any other kind. I cannot too strongly urge their claims as cut-worm destroyers, than by giving the statement of Mr. Cochran, to-wit: that he believed he could not possibly have coped with the worms without the aid of a large brood of chickens which he procured for that purpose.

Artificial Remedies.—The climbing cut-worms are easily headed off by a little vigilance. From the orchard planted upon light, warm soils they can be driven away entirely by claying the ground about the trees; a wheelbarrow full is well nigh enough for each tree when spread around its base and as far as the limbs extend. This is the most thorough and lasting. A small strip of tin, three inches wide, carefully secured around the body of the tree, will effectually prevent their ascension; if the tin is old and rusty it will require to be a little wider. Each night, after the swelling of the bud, an hour or two after midnight a slight jar of the tree will bring every one on it down, when they can be caught in a spread sheet and destroyed. This will have to be followed up till the bud has unfolded into the leaf, after which there is no longer anything to be apprehended from the worm. The reasons why the clay is so efficient, are two-fold: 1st—The worms seem to have an instinctive dislike to crawling over it. 2nd—In dropping from the tree on to the hard surface they are frequently disabled, and whether disabled or not, they cannot immediately burrow into it as in sand, and they are all the more exposed to their numerous midnight enemies which are ever watching for them.

For the common field cut-worms, I am convinced that there is no better remedy, as a rule, than hunting and killing them. It is generally believed that ashes and lime used about plants will keep off cut-worms, and I might fill pages with recorded experiments, going to prove the good effects of these substances. The experimenters generally forget, however, that there is a period in the life of these worms when they of themselves go down in the earth and disappear, and anything applied just before this happens is sure to be heralded forth as a perfect remedy. Experiments show, however, that when placed in a box with separate quantities of ashes, lime, salt and mold, they will burrow and hide in all of them, but especially in the ashes and mold. Soot seems to be more obnoxious to them, and, although I have not yet had an opportunity to give it a thorough test, I do not wish to discourage its trial. Fall plowing, to be efficacious, must be done very late in the fall, when the worms are numbed with cold, and then I think it is of doubtful utility further than it exposes them to the attacks of enemies, including birds.

In a case like that, communicated by Mr. Allen, it would pay to dig a narrow ditch around the part of the field infested, the outward side to be made smooth and slanting under; for these worms cannot crawl up a perpendicular bank of earth. On the same principle, many an one may be entrapped by making smooth holes with a stick around hills of corn or other plants, and on going over the same ground the next day, those that are thus entrapped can be crushed by the end of the same stick. In corn fields that have been subject to the attacks of cut-worms, it is well to plant so much seed as will enable them to glut their appetites without taking all the stalks in the hill, and in this light the following lines contain a deal of wisdom:

"One for the black-bird and one for the crow,
Two for the cut-worm and three to grow."

INSECTS INFESTING THE POTATO.

As the potato forms one of our leading articles of diet, and is universally cultivated, an accurate knowledge of the insects which attack it, is of the utmost importance. A very full account of them was given in the October and November numbers of the AMERICAN ENTOMOLOGIST, and since the editions of those two numbers are entirely exhausted, I cannot do better than to transfer it, for the most part, to the pages of this report, with such additions and alterations as I have since found necessary.

We often see paragraphs in the papers, stating that "THE Potato Bug" has been very abundant and destructive in such a month and at such and such a place. Accompanying these statements, remarks are frequently added, that "THE Potato Bug" is preyed upon by such and such insects, so that we may soon expect to see it swept from off the face of the earth; and that, even if this desirable event should not take place, "THE Potato Bug" may be checked and controlled by such and such remedies.

Do the worthy men, who indite these notable paragraphs, ever consider for one moment, that there are no less than eleven distinct species of bugs, preying upon the potato plant within the limits of the United States? That many of these eleven species are confined within certain geographical limits? That the habits and history of several of them differ as widely as those of a hog and a horse? That some attack the potato both in the larva state and in the perfect or winged state; others in the perfect or winged state alone; and others again in the larva state alone? That in the case of eight of these insects there is but one single brood every year, while of the remaining three there are every year from two to three broods, each of them generated by females belonging to the preceding brood? That nine of the eleven feed externally upon the leaves and tenderer stems of the potato, while two of them burrow, like a borer, exclusively in the larger stalks? Finally, that almost every one of these eleven species has its peculiar insect enemies; and that a mode of attack, which will prove very successful against one, two or three of them, will often turn out to be utterly worthless, when employed against the remainder?

THE STALK-BORER—*Gortyna nitela*, Guénée.

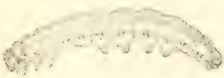
(Lepidoptera, Noctuidæ.)

[Fig. 35.]

2

This larva (Fig. 35 2,) is of a livid hue when young, with light stripes along the body, as shown in the figure. When full grown it generally becomes lighter, with the longitudinal lines broader, and at this time it more frequently resembles Figure 36. It commonly burrows in large stalks of the potato; but is not peculiar to that plant, as it occurs also in the stalks of the tomato, and in those of the dahlia and aster and other garden flowers. I have likewise found it boring through the cob of growing Indian corn, and strangely confining itself to that portion of the ear: though it is likewise found occasionally in the stem of that plant. By way of compensation, it is particularly partial to the stem of the common cocklebur (*Xanthium strumarium*); and if it would only confine itself to such noxious weeds as this, it might be considered as a friend instead of an enemy. In 1868 it was more numerous than

[Fig. 36.]



usual, and was particularly abundant along the Iron Mountain and Pacific roads.

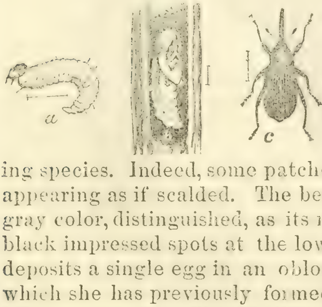
Never having found this worm earlier than June and July, nor obtained the moth from the very earliest matured ones, till the latter part of August and fore part of September, this insect must necessarily be single brooded, the egg requiring longer to hatch, and the larva longer to develop than of many other moths. Leaving the stalk in which they have burrowed the latter part of July, they descend a litte below the surface of the ground and in three days become chrysalids. These are of the normal form, with two fine bristles at the extremity of the body, usually closed so as to form a point, but readily opened V-shaped at the will of the insect, as with hundreds of others of the same class. I have had the moths issue as early as the 30th of August and as late as the 26th of September, and in one instance it emerged during a freezing night, being quite dull and numb at the time, thus showing beyond a doubt that the moths hybernate in a state of torpor, and then deposit their eggs, singly, on the plant destined for the worm, during the months of April and May. This moth (Fig, 35, 2) is of a mouse gray color with the fore wings finely sprinkled with Naples-yellow and having a very faint lilac-colored hue; but distinguished mainly by an arcuated pale line running across their outer third.

REMEDY—*Prevention.*—The careful florist, by an occasional close inspection of his plants about the beginning of July, may detect the point at which the borer entered, which is generally quite a distance from the ground, and can then cut him out without injury to the plant. As this is not feasible in a large potato field, care should be taken to prevent his attacks another year as far as it is possible to do so, by hunting for him wherever a vine is seen to suddenly wilt.

THE POTATO STALK-WEEVIL—*Baridius trinotatus*, Say.

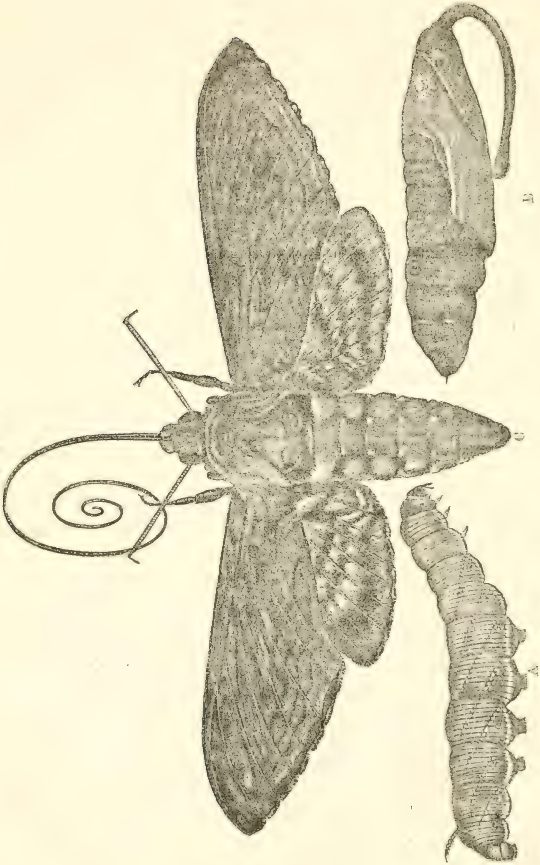
(Coleoptera, Curculionidæ.)

[Fig. 37.]



This insect is more particularly a Southern species, occurring abundantly in the Middle States, but, according to Dr. Harris, being totally unknown in New England. I found it in our own State last summer, equally as abundant as the preceding species. Indeed, some patches were utterly ruined by it, the vines appearing as if scalded. The beetle (Fig 37 *c*) is of a bluish or ash-gray color, distinguished, as its name implies, by having three shiny black impressed spots at the lower edge of the thorax. The female deposits a single egg in an oblong slit about one-eighth inch long, which she has previously formed with her beak in the stalk of the potato. The larva subsequently hatches out, and bores into the heart of the stalk, always, proceeding downwards towards the root. When

[Fig. 38.]



full grown, it is a little over one-fourth inch long (Fig. 37, *a*), and is a soft whitish, legless grub, with a scaly head. Hence it can always be readily distinguished from the larva of the Stalk-borer, which has invariably sixteen legs, no matter how small it may be. Unlike this last insect, it becomes a pupa (Fig. 37, *b*) within the potato stalk which it inhabits; and it comes out in the beetle state about the last of August or the beginning of September. The stalk inhabited by the larva almost always wilts and dies, and this wilting is first noticed in the latitude of St Louis, about the first of July, So far as is at present known it attacks no other plant but the potato, and the perfect beetle, like many other snout-beetles, must of course live through the winter to reproduce its species in the following spring.

Remedy.—Same as with the foregoing species. Burn all the vines which wilt from its attacks—roots and all, for it almost always works below ground. The Stalk-borer must be *searched* for, if one will be sure of killing him as he *leaves* the stalk to transform; but as this Stalk-weevil transforms within the vine, one may be pretty sure of destroying it by burning the vines when they first wilt.

THE POTATO OR TOMATO-WORM—*Sphinx 5-maculata,* Haw.

(Lepidoptera, Sphingidæ.)

This well known insect, the larva of which is illustrated on the opposite page (Fig. 38, A), is usually called the Potato-worm, but it is far commoner on the closely allied tomato, the foliage of which it often clears off very completely in particular spots in a single night. Many persons are afraid to handle this worm, from an absurd idea that it has the power of stinging with the horn on its tail. But this is a vulgar error and the worm is totally incapable of doing any direct harm to man, either with the conspicuous horn on its tail, or with any hidden weapon that it may have concealed about its person. In fact, this dreadful looking horn is not peculiar to the Potato-worm, but is met with in almost all the larvæ of the large and beautiful group to which it belongs (*Sphinx* family.) It seems to have no special use, but, like the bunch of hair on the breast of the turkey cock, to be a mere ornamental appendage.

When full-fed, which is usually about the last of August, the Potato worm burrows under ground and shortly afterwards transforms into the pupa state (Fig. 38, B). The pupa is often dug up in the spring from ground where tomatoes or potatoes were grown in the preceding season; and most persons that meet with it suppose that the singular, jug-handled appendage at one end of it is its *tail.* In reality, however, it is the *tongue-case*, and contains the long pliable tongue which the future moth will employ in lapping up the nectar of the flowers, before which, in the dusky gloom of some warm, balmy summer's evening, it hangs for a few moments suspended in the air, like the glorified ghost of some departed botanist.

The moth itself (Fig. 38, C) was formerly confounded with the Tobacco-worm moth (*Sphinx Carolina*, Linnæus), which indeed it very closely resembles, having the same series of orange colored spots on each side of the abdomen. The gray and black markings, however, of the wings differ perceptibly in the two species; and in the Tobacco-worm moth there is always a more or less faint white spot or dot near the centre of the front wing, which is never met with in the other species. In Connecticut and other northern States where tobacco is grown, the Potato-worm often feeds upon the leaves of the tobacco plant, the true Tobacco-worm being unknown in those latitudes. In the more southerly States, on the other hand, and in Mexico and in the West Indies, the true Potato-worm is unknown, and it is the Tobacco-worm that the tobacco growers have to fight. While in the intermediate country both species may frequently be captured on the wing in the same garden and upon the same evening. In other words, the Potato-worm is a northern species, the Tobacco-worm a southern species; but on the confines of the two districts exclusively inhabited by each, they intermingle in varying proportions, according to the latitude.

REMEDIES.—This insect is so large and conspicuous that the most effectual mode of destroying it is by hand-picking. In destroying the worms in this manner care should be taken to leave alone all those specimens which one finds covered with little white oval cocoons, as these are the cocoons of little parasites* which materially assist us in its subjugation.

THE STRIPED BLISTER-BEETLE—*Lytta vittata*, Fabr.

(Coleoptera Meloïdæ.)

The three insects figured and described above infest the potato plant in the larva state only, the two first of them burrowing internally in the stalk or stem, the third feeding upon its leaves externally. Of these three the first and third are moths or scaly-winged insects (order *Lepidoptera*), so called because the wings of all the insects belonging to this large group are covered with minute variously-colored scales, which, on the slightest touch, rub off and rob the wing of all its brilliant coloring. The second of the three, as well as the next four foes of the potato, which I shall notice, are all of them beetles or shelly-winged insects (order *Coleoptera*), so called because what would normally be the front wing is transformed here into a more or less hard and shelly wing-case, which, instead of being used as an organ of flight, is employed merely to protect and cover the hind wings in repose. To look at any beetle, indeed, almost any inexperienced person would suppose that it has got no wings at all; but in reality nearly all beetles have full sized wings snugly folded up under their wing-cases, and, whenever they choose it, can fly with the greatest

* There are two distinct parasites which attack this worm, both species being very much of a size. One issues from the worm and spins a *smooth* white silken cocoon which it fastens by one end to the skin of the worm, and in due time produces a fly which Mr. Norton informs me is an undescribed species of *Blacus*, West. (*Braconides polymorphi*). The other species forms an immense mass of loose woolly cocoons and produces an apparently undescribed species of *Microgaster*.

ease. This is the case with the four following beetles which infest the potato. As these four species all agree with one another in living under ground and feeding upon various roots, during the larva state, and in emerging to attack the foliage of the potato, only when in the course of the summer they have passed into the perfect or beetle state; it will be quite unnecessary to repeat this statement under the head of each of the four. In fact, the four are so closely allied, that they all belong to the same family of beetles, the blister-beetles (*Lytta* family)—to which also the common imported Spanish-fly or blister-beetle of the druggist appertains—and all of them will raise just as good a blister as that does, and are equally poisonous when taken internally in large doses. In Missouri, these blister-beetles were more numerous and more injurious in 1868 than the dreaded Colorado Potato-beetle.

The Striped Blister-beetle (Fig. 39) is almost exclusively a southern species, occurring in particular years very abundantly on the potato vine in Central and Southern Illinois, and in our own State, though according to Dr. Harris, it is also occasionally found even in New England. In some specimens, the broad outer black stripe on the wing-cases is divided lengthways by a slender yellow line, so that instead of *two* there are *three* black stripes on each wing-case; and in the same field all the intermediate grades between the two varieties may be met with; thus proving that the four-striped individuals do not form a distinct species, as was formerly supposed by the European entomologist, Fabricius, but are mere varieties of the same species to which the six-striped individuals appertain.

[Fig. 39.]

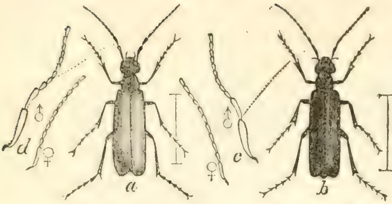
The late Samuel P. Boardman, of Lincoln, Illinois, discovered that this Striped Blister-beetle, like the Colorado beetle, eats all other potato tops in preference to Peach-blows. (See *N. Y. Sem. Tribune*, July 13, 1868.) This is certainly a new fact, so far as regards the former species, though it has long been ascertained to be true of the latter, but as I shall presently show, the Margined Blister-beetle has the same tastes.

THE ASH-GRAY BLISTER-BEETLE*—*Lytta cinerea*, Fabr.

This species (Fig. 40 *a*, male) is the one commonly found in the more northerly parts of the Northern States, where it usually takes the place of the Striped Blister-beetle figured above. It is of a uniform ash-gray color; but this color is given it by the presence upon

* In the male of this species, but not in the female, the first two joints of the antennæ are greatly elongated and dilated; which is also the case with the species next to be referred to. (Fig. 40 *d*, represents the male antennæ, above; that of female below.) Hence, in splitting up the extensive and unwieldy old genus (*Lytta*), these and certain allied species have been very properly placed in a genus by themselves (*Macrobasis*); while the Striped Blister-beetle and the Margined Blister-beetle, not possessing this peculiarity, are grouped together under a distinct genus (*Epicauta*). Practical men, however, who do not desire to trouble their heads with these niceties, will find it most convenient to class them all together under the old genus (*Lytta*); and this we have accordingly done.

[Fig. 40.]



its body of minute ash-gray scales or short hairs, and whenever these are rubbed off, which happens almost as readily as on the wings of a butterfly, the original black color of its hide appears. It attacks not only potato vines, but also honey-locusts, and especially the English or Windsor bean, and I found it quite abundant on the Early Snap bean at Hermann, last summer. It also attacks the foliage of the apple-tree, and likewise gnaws into the young fruit.

THE BLACK-RAT BLISTER-BEETLE—*Lytta murina*, Le Conte.

This species (Fig. 40 *b*, male) is sometimes found upon the potato in the month of July, and early in August. In 1867 it was found by Mr. D. W. Kauffman, to swarm on the potato vines near Des Moines, Iowa; but I have not yet met with it in Missouri.

THE BLACK BLISTER-BEETLE—*Lytta atrata*, Fabr.

This species is very similar in appearance to the Black-rat Blister-beetle; the latter being distinguishable from it only by having four raised lines placed lengthwise upon each wing-case and by the two first joints of the antennæ being greatly dilated and lengthened in the males as shown at Figure *c*. The Black Blister-beetle appears in August and September, and is very common on the flowers of the Golden-rod. I learned from several parties, while attending the October meeting of the Meramac Horticultural Society, at Eureka, that it had been quite numerous on the potatoes in that vicinity, and that they did much damage in some patches. The severe drouth of the summer had retarded the development of the tubers, so that this beetle attacked the vines before the latter were formed; but as a general rule, it makes its appearance too late in the season to do great damage.

THE MARGINED BLISTER-BEETLE*—*Lytta marginata*, Fabr.

[Fig. 41.]

This species (Fig. 41) may be at once recognized by its general black color, and the narrow ash-gray edging to its wing-cases. It usually feeds on certain wild plants; but I found it quite abundant on potatoes last summer, both in our own State and in Illinois. It appears not to attack the Peach Blow variety, for Mr. Wm. Brown, of Eureka. informs me that he had a patch of Quaker Russetts by the side of another patch of Peach Blows, and while the former were entirely eaten up by it, the latter were untouched.

* This is the name formerly given by almost all entomologists to this species; and a most appropriate one it is, in view of the remarkable ash-gray margin of its black wing-cases (*elytra*). But of late years it has been discovered, that, as long ago as the middle of the last century, and several

REMEDIES.—The same remedies will apply equally to all five of the Blister-beetles that have just been described. Let it be remembered that during the heat of the day, these beetles are ready with their wings and may be driven from the vines. Thus the most practical and efficient mode of destroying them, is to drive them into a windrow of hay or straw, and kill them by setting fire to it. As they all appear rather late in the season, I should recommend the planting of early varieties, which will be more likely to escape their attacks; and especially of the Peach Blow variety, the leaves of which seem to be more distasteful to them than those of any other variety.

THE THREE-LINED LEAF-BEETLE—*Lema trilineata*, Olivier.—(Coleoptera, Chrysomelidæ.)

[Fig. 42.]

The three first insects, described and figured above as infesting the potato-plant, attack it only in the larva state. The five next, namely the five Blister-beetles, attack it exclusively in the perfect state. The three that remain to be considered attack it both in the larva and in the perfect state, but go underground to pass into the pupa state, in which state—like all other Beetles, without exception—they are quiescent, and eat nothing at all.

The larva of the Three-lined Leaf-beetle may be distinguished from all other insects that prey upon the potato by its habit of covering itself with its own excrement. In Figure 42 *a*, this larva is shown in profile, both full and half grown, covered with the soft, greenish excrementitious matter which from time to time it discharges. Figure 42 *c*, gives a somewhat magnified view of the pupa; and Figure 42 *b*, shows the last few joints of the abdomen of the larva, magnified, and viewed, not in profile, but from above. The vent of the larva, as will be seen from this last figure, is situated on the upper surface of the last joint, so that its excrement naturally falls upon its back, and by successive discharges is pushed forward towards its head, till the whole

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years before Fabricius named and described this insect as the "Margined Blister-Beetle" (*Lytta marginata*), it was named and described as the "Ash-gray Blister-beetle" (*Lytta cinerea*), by Foerster. Hence, in accordance with the inexorable "law of priority," the obedient scientific world has been called upon to adopt Foerster's name for this species; and as two species belonging to the same genus can not, of course, have the same specific name, the true Ash-gray Blister-beetle of Fabricius (*Lytta cinerea*), which is really ash-gray all over, has been re-christened by the name of "Fabricius' Blister-beetle" (*Lytta Fabricii.*) Positively, this continual chopping and changing in scientific nomenclature is getting to be an unbearable nuisance, and must be put a stop to. Otherwise one-half of the time of every entomologist, which might be much better occupied in studying out scientific *facts*, will be frittered away in studying out scientific *phrases*.

Many writers, in giving the scientific designation of an insect, neglect to add the name of the author who first described it. This practice often leads to error, uncertainty, and confusion, as the preceding example will at once show. If, for instance, we write simply "*Lytta cinerea*," how can the reader tell whether we mean the species described under that name by Foerster, or the very distinct species described under the very same name "*cinerea*" by Fabricius? Whereas, if we add the author's name, all doubts upon the subject are at once removed; and we can snap our fingers at those wearisome and interminable disputes about the priority of names and the law of priority, which take up so much space in scientific papers, while they add absolutely nothing to our knowledge of the facts recorded by the finger of God in the great book of Nature.

upper surface of the insect is covered with it. In other insects, which do not indulge in this singular practice, the vent is situated either at the extreme tip of the abdomen or on its lower surface.

There are several other larvæ, feeding upon other plants, which commonly wear cloaks of this strange material, among which may be mentioned one which is very common upon the Sumach, and which produces a jumping, oval Leaf-beetle (*Blepharida rhois*, Foerster), about a quarter of an inch long, and of a yellow color, speckled with brick-red. The larvæ of certain Tortoise-beetles (*Cassida*), some of which feed on the Morning Glory and the Sweet Potato vines, adopt the same practice, but in their case there is a forked process at the tail which curves over their backs and receives the requisite supply of excrement.

Many authors have supposed that the object of the larva, in all these cases, is to protect its soft and tender body from the heat of the sun. This can scarcely be the correct explanation, because then they would throw away their parasols in cold cloudy weather, which they do not do. In all probability, the real aim of Nature, in the case of all these larvæ, is to defend them from the attacks of birds and of cannibal and parasitic insects.

There are two broods of this species every year. The first brood of larvæ may be found on the potato vine toward the latter end of June, and the second in August. The first brood stays underground about a fortnight before it emerges in the perfect beetle state; and the second brood stays there all winter, and only emerges at the beginning of the following June. The perfect beetle (Fig. 43) is of a pale yellow color, with three black stripes on its back, and bears a general resemblance to the common Cucumber-beetle (*Diabrotica vittata*, Fabr., Fig 44). From this last species, however, it may be readily distinguished by the remarkable pinching in of the sides of its thorax, so as to make quite a lady-like waist there, or what naturalists call a "constriction." It is also on the average a somewhat larger insect, and differs in other less obvious respects. As in the case of the Colorado Potato-beetle, the female, after coupling in the usual manner, lays her yellow eggs (Fig. 42 *d*) on the under surface of the leaves of the potato plant. The larvæ hatching from these require about the same time to develop, and when full grown descend in the same manner into the ground, where they transform to pupæ (Fig. 42 *c*) within a small oval chamber, from which in time the perfect beetle comes forth.

[Fig. 43.]

[Fig. 44.]

The Three-lined Leaf-beetle, in certain seasons, is a great pest in the Eastern States; but, it has never yet occurred in the Valley of the Mississippi in such numbers as to be materially injurious.

THE CUCUMBER FLEA-BEETLE—*Haltica cucumeris.**—Harris.

(Coleoptera, Chrysomelidæ.)

[Fig. 45.]

This minute Beetle (Fig. 45) belongs to the Flea-beetles (*Haltica* family), the same sub-group of the Leaf-beetles (*Phytophaga*) to which also appertains the notorious Steel-blue Flea-beetle (*Haltica chalybea*, Illiger), that is such a pest to the vineyardist. Like all the rest of the Flea-beetles, it has its hind thighs greatly enlarged, which enables it to jump with much agility. It is not peculiar to the potato, but infests a great variety of plants, including the cucumber, from which it derives its name. It operates by eating minute round holes into the substance of the leaf which it attacks, but often not so as to penetrate entirely through it. In South Illinois whole fields of potatoes may often be observed looking seared and yellow, and with their leaves riddled with the round holes made by this insect. The larva feeds internally upon the substance of the leaf, like that of the closely-allied European Flea-beetle of the turnip (*Haltica nemorum*, Linn.); and, from its near relationship to that insect, we may infer that it goes underground to assume the pupa state, that it passes through all its stages in about a month, and that there are two or three broods of them in the course of the same season.

THE COLORADO POTATO-BEETLE—*Doryphora 10-lineata*, Say.

(Coleoptera, Chrysomelidæ.)

ITS PAST HISTORY AND FUTURE PROGRESS.

[Fig. 46.]

Up to the autumn of 1865, it was generally supposed by economic entomologists, that this destructive insect had existed from time immemorial in the Northwestern States, feeding upon some worthless weed or other; and that of late years, from some unexplained cause, it had all of a sudden taken to attacking the potato-plant. In October, 1865,

* Erroneously considered by some authors as identical with the *Haltica pubescens* of Illiger. In this last species, according to Dr. J. L. LeConte, the thorax, instead of being shining, as in our insect, is opaque, with large, dense punctures.

Mr. Walsh showed that originally its exclusive home was in the Rocky Mountains, where it had been known to exist for at least forty-five years feeding upon a wild species of potato peculiar to that region (*Solanum rostratum*, Dunal); that when civilization marched up to the Rocky Mountains, and potatoes began to be grown in that region, it gradually acquired the habit of feeding upon the cultivated potato; that in 1859, spreading eastward from potato patch to potato patch, it had reached a point one hundred miles to the west of Omaha city, in Nebraska; that in 1861, it invaded Iowa, gradually, in the next three or four years, spreading eastward over that State; that in 1864 and 1865, it crossed the Mississippi, invading Illinois on the western borders of that State, from the eastern borders of North Missouri and Iowa, upon at least five different points on a line of two hundred miles; and that in all probability it would in future years "travel onwards to the Atlantic, establishing a permanent colony wherever it goes, and pushing eastward at the rate of about fifty miles a year." (*Practical Entomologist*, Vol. I, No. 1.) A remarkable peculiarity in the eastern progress of this insect was subsequently pointed out by the same writer, in 1866, namely, that "in marching through Illinois in many separate columns, just as Sherman marched to the sea, the southern columns of the grand army lagged far behind the northern columns." (*Ibid*, II, p. 14.)

Now, let us see how far the predictions above, have been verified By the autumn of 1866, the Colorado Potato-beetle, which appears to have invaded the south-west corner of Wisconsin at as early a date as 1862 (*Ibid*, II, p. 101), had already occupied and possessed a large part of the cultivated or southern parts of that State; and in Illinois if we draw a straight line to connect Chicago with St. Louis, nearly all the region that lies to the north-west of that line was overrun by it. It subsequently invaded parts of South Illinois, occurring in Union, Marion, and Effingham counties, in 1868; and already in 1867 it had passed through the eastern borders of North and Central Illinois into Western Indiana, and the south-west corner of Michigan; and finally, in 1868 it made its appearance in many different places in Indiana, and as the following communication from a Cincinnati correspondent of the *Ohio Farmer*, under date of July, 1868, will show, it has even spread into Ohio.

"About three years ago when in your office at Cleveland, you presented me with samples of this devastating insect, the first I had seen; they have been preserved in the collection of one of the best entomologists of Ohio. You had received the beetles from some correspondent in Iowa, where it was then ravaging the crops and where it continues to be very destructive. We soon learned that the insects were progressing eastward at the computed rate of about thirty miles a year, and we began to calculate the time when we might expect its appearance in Ohio—which we did not anticipate for some years.

"Having crossed the Mississippi at Rock Island the insects soon traversed the State of Illinois and reached the shores of Lake Michigan, where it might have met a watery grave, but, unfortunately its course was only deflected southward, and there were other cohosts of the invaders, traversing lower parallels, so that by convergence, the force was multiplied and great fears were anticipated by the potato-growers of Northern Indiana and Ohio, and it was supposed that Northern Ohio would be invaded before the Southern portion of this State.

"At the last annual meeting of the Indiana Horticultural Society, in January 1868, the existence of this insect was reported in several counties in the north-western part of that State during 1867, leading us to apprehend that the day of their approach to us was not so distant as we had fondly hoped. Correspondents now inform us that this beetle has reached Lafayette, Indianapolis, Danville, and other points of central Indiana, so that its progress eastward continues with increasing speed.

"We have now to record the actual presence of the Ten-lined Spearman, (*Doryphora* 10-*lineata*,) in the south-western corner of Ohio, a very few specimens of this pest having been taken within the past week in Hamilton county."

Thus it appears that its average annual progress towards the east has been upwards of seventy miles. At the same rate of progression it will touch the Atlantic ocean in about ten years from now, or A. D. 1878.

"But," it will be asked, "how could any entomologists make the mistake of supposing that the Colorado Potato-beetle had always existed in the Northwestern States?" The answer is, that, as was proved three years ago in the article already referred to they inadvertently confounded together two entirely distinct, but very closely allied species, the bogus Colorado Potato-beetle (*Doryphora juncta*, Germar), and the true Colorado Potato-beetle (*Doryphora* 10-*lineata*, Say). The former of these has existed in the South-west from time immemorial, and has long since been known to feed in the larva state upon the horse-nettle (*Solanum carolinense*, Linn,) a wild plant which is exceedingly adundant in our own State. In 1863 Mr. Glover stated that he "had found an insect similar to the Ten-striped Spearman [or true Colorado Potato-beetle] on the common horse-neetle in Georgia." (*Agr. Department Rep.*, p. 579). In 1867 he assured me that this insect, found by him on the horse-nettle in Georgia four years before, was the bogus Colorado Potato-beetle (*D. juncta*,) and that "a Mr. Walter had also found it feeding upon the Egg-plant in Montgomery, Alabama." I discovered this same species in Kentucky in 1864, feeding in conjunction with its larvæ upon a plant, which could have been nothing else but the horse-nettle; and last fall I met with it in great numbers, in St. Louis and Jefferson counties in this State, feeding upon the same plant, in company with its larvæ; and in one instance the larvæ of both the true and the bogus species occurred in company. Thus it appears to inhabit at least five southerly regions, namely South Illinois, Missouri, Kentucky, Georgia and Alabama.

The true Colorado Potato-beetle as has been already stated, only immigrated into Illinois in 1864, and in its native home, the Rocky Mountains, feeds naturally upon another wild species of potato, which is quite distinct from the horse-nettle, and is peculiar to the Rocky Mountain region. Again, the former species has never yet been known to attack the cultivated potato, and in all likelihood never will do so; for, as it has existed in all likelihood never will do so; for, as it has existed in Illinois, for at least 14 years, and in Georgia for at least 44 years, without ever having been known to attack this plant, which has been growing all that time in these two States, it is not at all probable that it will do so at any future time. The latter species, on the other hand, acquired this habit, as was shown before, in the region of the Rocky Mountains, when for the first time the potato was introduced there, some twenty years ago; and from that region the potato-feeding race of this insect has since been spreading further and further every year towards the east. Finally the bogus Colorado Potato-beetle is more peculiarly a southern species, occurring in the more southerly portion of Illinois, and in Missouri, Kentucky, Georgia, and probably Alabama, while the true Colorado Potato-beetle is originally an Alpine species, its native home being the canons (kanyons) of the Rocky Mountains, and it therefore thrives best and spreads fastest in the more northerly regions, such as Nebraska, Iowa, Minnesota, Wisconsin and North Illinois; while in South Illinois, Missouri, and Kansas, it neither thrives so well nor spreads so rapidly.

The question whether the true Colorado Potato-beetle has existed for an indefinitely long time in the country that lies to the east of the Mississippi river, or whether it is not the bogus Colorado Potato-beetle that has there been mistaken for it, while the true Colorado Potato-beetle has in reality immigrated into that country from the Rocky Mountain region within the last four or five years, may seem to some of merely theoretical interest. It is, however, of great practical importance. On the first supposition it is not probable that this bitter enemy of the potato will travel onwards and onwards towards the Atlantic; on the second supposition it will most likely traverse Ohio within a year or two, spread like a devouring flame through the great potato-growing State of Michigan, and finally pass eastwards into Pennsylvania, New York, and New England. I shall, therefore, briefly point out the minute but invariable characters which distinguish them both in the larva and perfect beetle states.

I had an excellent opportunity of comparing the larvæ of *juncta* with those of *10-lineata*, from alcoholic specimens which were kindly sent to Mr. Walsh by Mrs. H. C. Freeman, of Cobden, Illinois, and from numerous living specimens which I found around St. Louis.

At Figure 46, the true Colorado Potato-beetle is represented in all its varied stages; *b*, *b*, *b* representing the larvæ of three different growths and sizes. In the annexed Figure 47, *b*, *b*, represents the full grown larvæ of the bogus Colorado Potato-beetle. It will be seen at once that the head of the former is black, that the first joint behind the head is pale and edged with black behind only, that there is a double row of black spots along the side of the body, and that the legs are black, the ground-color of the body being of a Venetian-red. In the other larva (Fig. 47 *b*), on the contrary, the head is of a pale color, the first joint behind the head reddish-brown and edged all round with black; there is but a single row of black spots along the side of the body and the legs are pale, while the ground color of the body is of a pale cream, tinged with pink or flesh color. Such are the distinguishing characteristics of the two larvæ; but it is an interesting fact that these characters are not always constant. Thus the individuals of the second (last summer's) brood of 10-*lineata* larvæ which fed on the horse-nettle in my garden were all of them much paler than were those of the first, potato feeding brood, from which they had descended; and furthermore the lower row of spots was very indistinct and in many entirely obsolete, while the head, instead of being black was entirely brown. Whether this variation from the normal type was due to the food-plant or not, I shall not at present offer an opinion, but I should have been doubtful about the species had I not bred the perfect beetle (10-*lineata*) from them. Again as I shall immediately show the young larva of *juncta* similates in its markings the mature larva of 10-*lineata*.

[Fig. 47].

The eggs of 10-*lineata* (Fig. 46, *a*, *a*) are of a translucent orange-red color, while those of *juncta* (Fig. 47, *a*, *a*) are whitish, with a faint tinge of flesh-color, and still more translucent. The newly hatched larvæ of the former are of a dark Venetian-red, and they become lighter as they grow older, while the newly hatched larvæ of the latter have the body as light as the full grown individuals. Singularly enough, however, the newly hatched larvæ of *juncta* instead of having the light yellow head and the single row of spots of the mature individuals, have a brown head and *two* rows of spots, the lower being less distinct than the upper row, and placed exactly in the same position as the lower row on the *mature* larvæ of 10-*lineata* (see Fig. 46 *b*, lower figure).

I subjoin a more full description of *Doryphora juncta*. That of the larva of *Doryphora* 10-*lineata* will be found in Dr. Fitch's *N. Y. Reports*, Vol. III, pp. 231–2. According to Dr. Fitch, the ground color of this last larva is "pale-yellow" in the mature state; according to Dr. Shimer, in his excellent article on the preparatory stages of this insect, it is "orange." In the immature larvæ it is almost always of a dull Venetian-red, though in the mature larvæ the color becomes lighter. Indeed in some instances it becomes almost as pale as that of *D. juncta*. I saw a number of such pale individuals among the late broods of last summer, though I had never seen them so pale before, notwithstanding I have witnessed great numbers of them every year, since 1863.

DORYPHORA JUNCTA, Germar.—*Mature larva.*—General color a pale yellowish flesh-color. Head bright gamboge-yellow, with the antennæ placed behind the base of the mandibles, short and very robustly conical, three-jointed, joints 2 and 3 black. Precisely as in 10-*lineata*, there are six small simple black eyes upon each side, one pair longitudinally arranged and placed below the antennæ, the other two pairs arranged in a square and placed a little above and behind the antenna; tip of the mandibles black. Body, with the dorsum of joint 1 composed of a separate transverse horny plate, rounded at the sides, of a rich shiny vandyke-brown, with the edges somewhat raised, and jet black and with a fine line of a lighter color running through the middle from the posterior to the anterior edge. Joints 1—3 each, with a lateral horny black tubercle, that of joint 1 placed below and behind the horny prothoracic plate, and enclosing a spiracle. Joints 4—11 each with a similar lateral tubercle enclosing a spiracle; but the row composed of these eight tubercles is placed a little above the row of three tubercles on joints 1—3, and the last four of the eight are gradually smaller and smaller, until that on joint 8 is reduced to a simple black spiracle. Legs pale yellow; coxæ exteriorly dark brown, the two hinder pairs each more and more so, with a geminate horny plate above each, which becomes more and more brown in each successive pair. An exterior dusky dot, or small spot, on the tip of the femur and of the tibia. Tarsus small, one-jointed, brown, and with a black claw.

The body has a distinct translucent dorsal heart-line, and has usually a shade of the same color both above and below the lateral row of black tubercles; while there are two transverse dark-brown bands across the extreme tip of the body, which is used as an anal proleg. This larva, when well fed, is very smooth and swollen, though it soon becomes wrinkled after fasting. The pink tint of the body is more intense on the neck and between the legs.

Now let us see what are the differences in the perfect beetle state of these two insects, in which state even a practised entomologist would, at first sight, be apt to confound them together. Indeed, so minute are the differences, that in a drawing of the natural size, it is scarcely possible to exhibit them, but with the greatly enlarged leg and wing-case of each species, which are given in the foregoing figures, we shall readily be enabled to do so. Figure 46, *d*, *d*, exhibits the true Colorado Potato-beetle; Figure 47, *c*, the bogus Colorado Potato-beetle, each of its natural size. Figure 46, *e*, shows the *left* wing-case enlarged, and Figure 46, *f*, an enlarged leg of the former; Figure 47, *a*, the *left* wing-case enlarged, and Figure 47, *e*, an enlarged leg of the latter. On a close inspection it will be perceived that in the former (Fig. 46, *e*) the boundary of each dark stripe on the wing-cases, especially towards the middle, is studded with confused and irregular punctures, partly inside and partly outside the edge of the dark stripe; that it is the third and fourth dark stripes, counting from the outside, that are united behind; and that in the leg both the knees and the feet are black. In the latter (Fig. 47, *d*), on the contrary, the dark stripes are accurately edged by a single regular row of punctures placed in a groove (*stria*); it is the second and third stripes—not the third and fourth—counting from the outside, that are united behind, the space between them being almost always brown; and the leg is entirely pale, except a black spot on the middle of the front of the thigh.

The spots on the thorax, in either of the above two species, are normally eighteen in number, arranged in the same very peculiar pattern which may be seen both in Figure 46, *d*, *d*, and in Figure 47, *c*; and precisely the same variations in this complicated pattern occur in either species.

Thus, these two beetles differ essentially from one another upon a strict comparison; but the general resemblance is so great that it is not to be wondered at that the two have been confounded together by several otherwise well qualified observers.

HABITS OF THE COLORADO POTATO-BEETLE.—This insect *can* fly, though it does so very reluctantly and only during the heat of the day. Its wings, like those of several allied species, are of a bright rose-color, and with its cream-colored body, and the five black stripes upon each wing-case, it presents a beautiful appearance as it flies abroad in the clear light of the sun. Its transformations were first made known by myself in the *Prairie Farmer* for August 8, 1863. Subsequently, in 1866, Dr. Shimer, of Mt. Carroll, detailed some additional particulars bearing on its habits, in a paper which he published in the *Practical Entomologist* (vol. 1, pp. 84–85). In the latitude of St. Louis there are three broods during the year, the last brood wintering over in the beetle state underground. They are usually dug up in the spring of the year in land that had been planted to potatoes the year before. The beetles issue of their own accord from the ground about the first of May, and the last brood of beetles enters the ground to hybernate during the month of October. Though, in general terms, this beetle may be said to be three-brooded, yet it may be found at almost any time of the year in all its different stages. This is owing to the fact that the female continues to deposit her eggs in patches from time to time—covering a period of about forty days; and also from the fact that among those larvæ which all hatch out in one day, some will develop and become beetles a week and even ten days earlier than others. Thus it may be that some of the late individuals of the third brood pass the winter in the pupa state, though the normal habit is to first transform to beetles. Each female is capable of depositing upwards of a thousand eggs before she becomes barren, and in from thirty to forty days from the time they were deposited, they will have produced perfect beetles. These beetles are again capable of depositing eggs in about two weeks after issuing from the ground, and thus, in about fifty days after the egg is laid, the offspring begins to propagate. The pupa of the Colorado Potato beetle is represented at Figure 46, *c*. It is formed in a little cavity which the larva had made perfectly smooth and hard, and it is of the same color as the larva. The beetle, on first emerging from it, is quite pale and soft, without any markings whatever.

Unlike many other noxious insects, this larva is not a general feeder, but is confined to plants belonging to the potato family (*Solanaceæ*), and especially to the genus to which the potato belongs (*Solanum*). Occasionally it feeds on the tomato, on the ground-cherry (*Physalis*), and on the imported Jamestown-weed, or gympson-weed (*Datura*). It prefers the horse-nettle (*Solanum carolinense*) to some varieties of the potato, and were it not that the nettle is considered a nuisance, on account of the difficulty of eradicating it when once introduced, it would be a good plan to encircle a potato field with a row of nettles, so as to concentrate the insects, and thus more readily destroy them. It is also even more destructive to the egg-plant than to the potato. Now, the egg-plant, the horse-nettle, and the potato, all three of them belong to the same genus (*Solanum*), as the wild plant upon which the larva originally fed in the Rocky Mountain region; but the egg-plant and the horse-nettle are botanically more closely related to the last than is the potato; being, like the Rocky Mountain potato, covered with thorny prickles, while the cultivated potato is perfectly smooth. On the other hand, the cultivated potato is much more nearly related to the Rocky Mountain species than is the tomato; which last has, by modern botanists, been removed from the genus to which the other two appertain, and placed in a genus by itself. It would seem, therefore, that the closer a plant comes to the natural food-plant of the insect, the better the insect likes it.

The beetles have been sent to me, as taken from other plants, and even from the raspberry, but I could never succeed in making them feed on any plant that did not belong to the potato family, though I am informed by my friend, Edgar Sanders, of Chicago, that they greedily attack the tubers after they are dug, and he has found as many as six in a single potato.

It is undoubtedly a most singular and noteworthy fact that, out of two such very closely allied species as the bogus and the true Colorado Potato-beetles, feeding respectively in the first instance upon very closely allied species of wild potato (*Solanum rostratum* and *S. carolinense*), the former should have pertinaciously refused, for about half a century, to acquire a taste for the cultivated potato, with which it was all the time in the closest and most immediate contact, while the latter acquired that taste as soon as ever it was brought into contact with that plant. But, after all, this is not so anomalous and inexplicable as the fact that the Apple-maggot Fly (*Trypeta pomonella*, Walsh), which exists both in Illinois, New York, and New England, and the larva of which feeds in Illinois upon the native haws, and has never once been noticed to attack the imported apple there, should, within the last few years, have suddency fallen upon the apple, both in New York and New England, and in many localities there, have become a more grievous foe to that fruit than even the imported Apple-worm (*Carpocapsa pomonella*, Linn.)*

Thinking that the bogus Colorado Potato-beetle might be compelled to feed on the potato in a state of confinement, I gave it every opportunity; but though the larvæ, when transferred from the horse nettle, fed more or less on potato leaves, they invariably became sickly and eventually died. But even if they had actually fed upon potato leaves quite freely in a state of confinement and developed into bee-

* See on this subject the First Annual Report on the Noxious Insects of Illinois, by Benj. D. Walsh, pp. 29-30, in the Transactions of the Illinois State Horticultural Society for 1867.

tles it by no means follows that the mother beetle would deposit her eggs upon the potato in a state of nature, and thereby compel her future progeny to feed upon that plant. That she will do so upon her natural food-plant, the horse-nettle, we know; and, according to Mr. Walter of Alabama, she will do so upon the egg-plant, which is thorny like the horse-nettle. But apparently she is indisposed to go one step further, and lay her eggs upon a smooth species of the same botanical genus, namely the potato.

NATURAL REMEDIES.—Persons not familiar with the economy of insects are continually broaching the idea that, because the Colorado Potato-beetle is in certain seasons comparatively quite scarce, therefore it is about to disappear and trouble them no more. This is a very fallacious mode of reasoning. There are many insects—for instance, the notorious Army-worm of the north (*Leucania unipuncta*, Haworth)—which only appear in noticeable numbers in particular years, though there are enough of them left over from the crop of every year to keep up the breed for the succeeding year. There are other insects—for instance the Canker-worm (*Anisopteryx vernata*, Peck)—which ordinarily occur in about the same numbers for a series of years, and then, in a particular season and in a particular locality, seem to be all at once swept from off the face of the earth. These phenomena are due to several different causes, but principally to the variation and irregularity in the action of cannibal and parasitic insects. We are apt to forget that the system of Nature is a very complicated one—parasite preying upon parasite, cannibal upon cannibal, parasite upon cannibal, and cannibal upon parasite—till there are often so many links in the chain that an occasional irregularity becomes almost inevitable. Every collector of insects knows, that scarcely a single season elapses in which several insects, that are ordinarily quite rare, are not met with in prodigious abundance; and this remark applies, not only to the plant-feeding species, but also to the cannibals and the parasites. Now, it must be quite evident that if, in a particular season, the enemies of a particular plant-feeder are unusually abundant the plant-feeder will be greatly diminished in numbers, and will not be able to expand to its ordinary proportions until the check that has hitherto controlled it is weakened in force. The same rule will hold with the enemies that prey upon the plant-feeders, and also with the ememies that prey upon those enemies, and so on *ad infinitum.* The real wonder is, not that there should be occasional irregularities in the numbers of particular species of insects from year to year, but that upon the whole the scheme of creation should be so admirably dove-tailed and fitted together, that tens of thousands of distinct species of animals and plants are able permanently to hold their ground, year after year, upon a tract of land no larger than an ordinary State.

To illustrate the decrease in its numbers which took place in the State of Iowa from 1867–8, I will state that Mr. Henry Tilden, of Davenport, who had previously made tomato and potato growing a specialty, was forced to go to raising small grains on its account, in 1867, having lost 30 acres of potatoes by its ravages in 1866; while in 1867 Mr Suel Foster, of Muscatine, Iowa, offered a large premium to any one who would insure his crop of potatoes. Now I have received numbers of letters which go to show that the damage done to potatoes in Iowa in 1868 was comparatively very slight, and the following article which Mr. Foster published in the *Prairie Farmer* of May 16th 1868, sufficiently demonstrates that Mr. F. would have been the loser, had any insurance company seen fit to insure his crop on his own terms:

"For three years past I have given the most discouraging accounts of the ruinous destruction of our almost indispensable potato crop. I now have a word of encouragement. Last year I planted very sparingly of potatoes; the year before, by great perseverance, I succeeded in raising a few Early Goodrich and Harrison, by continual picking and killing the bugs, and last year planted the product on a new piece of land where no potatoes had been raised; but the bugs found them as soon as they were up; I picked the bugs awhile, then gave them up to their destruction, and the potatoes were nearly destroyed. About the first to the tenth of June the bugs began to diminish. We found the little red and black spotted lady bug quite numerous and active, eating the eggs of the potato bug. I didn't believe those little lady bugs could possibly destroy enough of the eggs of the potato bugs to materially check their increase; but there were but very few of the second brood that hatched in this part of the country, and our late and strong growing potatoes were a full crop.

"What became of the bugs that were so numerous in May and the first of June? The lady bug, with a little assistance from a few other insects, destroyed their eggs. Last May the weather was very wet and cold, yet the bugs increased, and although more stiff and clumsy than in dry, warm weather, they were hearty at their food. Had June been cold and wet, I should have thought their disappearance was caused by that; but June was a very favorable time for their increase and spread on the wing by night. The Colorado potato bugs nearly all disappeared here in June, and not a bug have we seen in plowing and digging in the ground this spring, while in former seasons we used to find them plentifully. I believe some will make their appearance this year, but I fully believe that the same cause which destroyed them so early last year—the lady bug and others, some of which preyed upon the young potato bugs—will prevent their increase this year. If the above are not the facts in this case, can any one tell us facts and theories that are more reliable? It is true, I am not as positive about this as if I had met a regiment of rebels, and had counted the dead and prisoners, to tell what had become of them. But we, in this region, do not expect the bug this year, and are planting potatoes with very little hesitation. Your readers may rely upon this as the fate of the potato bug for the present, and I will write you again in a month, or as soon as I get additional news from him.

"The Illinois correspondent of the *Country Gentleman*, writing from Champaign county, says:

"Those plowing old potato ground where these creatures operated extensively last year, find the ground full of the dormant wretches. We, at Muscatine, Iowa, will lend them our Benson's Horse Power Potato Bug Killer, but we can't spare our lady bugs."

The following enemies of the Colorado Potato-beetle, are among the most prominent which have been instrumental in checking its ravages during the past summer.

THE COLORADO POTATO-BEETLE PARASITE—*Lydella doryphoræ,* N. Sp.

(Diptera Tachinidæ.)

This fly (Fig. 48) has probably been more efficient in checking it than any one other insect, at least in our own State. Until last year no parasitic insect whatever was known to prey internally upon it, but this fly destroyed fully ten per cent. of the second brood and fifty per cent. of the third brood of potato-beetles that were in my garden. It bears a very close resemblance, both in color and size, to the common house fly, but is readily distinguished from the latter by its extremely brilliant silver-white face.

[Fig. 48.]

It may be seen throughout the summer months flying swiftly from place to place, and deftly alighting on fence or wall, where, basking in the sun, its silvery face shows to good advantage. As with the rest of the family to which it belongs, the habit of the female is to attach a single egg externally to the body of the Potato-beetle larva. This egg subsequently hatches into a little footless maggot, which burrows into the body of its living victim, and eventually destroys it, but not until it has gone underground in the usual manner. The victimized larva instead of becoming a pupa, and eventually a beetle, as it would have done had it not been attacked, begins to shrink as soon as it enters the ground, and gradually dies; while inside its shriveled skin the parasitic maggot contracts into a hard brown pupa, and in due time issues forth in the shape of the fly which I have figured. I am indebted to Mr. Wm. LeBaron, of Geneva, Illinois, for the generic determination of this fly. It belongs to the genus (or sub-genus *Lydella* Macquart, and is very closely allied to *Tachina* proper, with which it could properly be united, did not the great number of species require a division as a matter of necessity. I subjoin a more detailed description of the fly:

LYDELLA DORYPHORÆ, New Species.—Length 0.25. Alar expanse 0.48. Antennæ black. Palpi fulvous. Face silvery white. Front silvery, tinted with pale golden-brown, with a broad middle stripe black. Thorax cinereous with imperfect black stripes. Abdomen black and silvery-ash, changing into each other when viewed from different angles. When viewed from above: first segment deep black with a posterior border of silver-ash very narrow in the middle, much widened laterally, but abreviated at the sides of the abdomen. The other segments with the basal half silvery-ash, terminal half black. Legs black. Fourth longitudinal vein of the wings straight after the angle. Posterior transverse vein arcuate.

Described from numerous bred specimens.

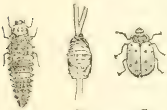
LADYBIRDS.—In the egg state the Colorado Potato-beetle is preyed upon by no less than four distinct species of Ladybirds. Foremost among them is the Spotted ladybird (*Hippodamia maculata*, DeGeer) which is one of our most common species and is of a pink color, marked with large black spots as in Figure 49. Next comes the Nine-spotted ladybird (*Coccinella 9-notata*, Herbst) which is of a brick-red color and marked with 9 small black spots as in Figure 50. Next, the Thirteen-spotted ladybird (*Hippodamia 13-punctata*, Linn.) which is also of a brick-red color but marked with 13 black spots as in Figure 51. And last but not least, the little species figured at 52, *a*, which may be known as the Convergent ladybird (*Hippodamia convergens*, Guer.) and which is of an orange-red color marked with black and white as in the figure. This last species alone has been of immense benefit in checking the ravages of the Potato-beetle. Its larva is represented of the natural size at Figure 52, *a* its colors being blue, orange and black; when full grown it hangs by the tail to the underside of a stalk or leaf and transforms into the pupa represented at Figure 52, *b*. In this state it is of the exact color of the Colorado beetle larva and is doubtless quite often mistaken for that larva and ruthlessly destroyed. It may readily be distinguished however by its quiescence, and let every potato grower learn well to recognize it and spare its life! The larvæ of all these ladybirds are more bloodthirsty in their habits than the perfect beetles, and the larva of the little Convergent ladybird is so essentially a cannibal that whenever other food fails, it will turn to and devour the helpless pupæ of its own kind. It is a rather cruel and withal a somewhat cowardly act to thus take advantage of a helpless brother; but in consideration of its good services, we must overlook these unpleasant traits in our little hero's character! All these larvæ bear a strong general resemblance, and with the aid of Figure 52 *a* and the annexed Figure 53, a good idea may be obtained of them. They run with considerable speed, and may be found in great numbers upon almost all kinds of herbage. The larvæ of certain species that prey upon the Hop Plant-louse in the East are well known to the hop-pickers as "black niggers" or "serpents," and are carefully preserved by them as some of their most efficient friends.

[Fig. 49.]

[Fig. 50.]

[Fig. 51.]

[Fig. 52.]



A B C

[Fig. 53.]

The eggs of ladybirds greatly resemble those of the Colorado Potato-beetle, and are scarcely distinguishable except by their smaller size and by a much smaller number being usually collected together in a single group. As these eggs are often laid in the same situation as those of the potato-feeding insect, care must be taken by persons who undertake to destroy the latter, not to confound those of their best friends with those of their bitterest enemies.

THE SPINED SOLDIER-BUG.—In the larva state the Colorado Potato-beetle is extensively depredated on, both in Illinois, Missouri and

[Fig. 54.]

Iowa, by the Spined Soldier-bug (*Arma spinosa*, Dallas), which is of an ochre-yellow color and is represented with one pair of wings closed and the other pair extended, in the annexed Figure 54.—Thrusting forwards his long and

[Fig. 55.]

stout beak, he sticks it into his victim, and in a short time pumps out all the juices of its body and throws away the empty skin. He belongs to a rather extensive group (*Scutellera* family) of the true bugs (*Heteroptera*), distinguishable from all others by the very large scutel, which in this genus is triangular, and covers nearly half his back. Most of the genera belonging to this group are plant-feeders, but there is a sub-group (*Spissirostres*) to which our cannibal friend belongs, characterized by the robustness of their beaks, and all of these, seem to be cannibals. To illustrate to the eye the difference between the beaks of the cannibal sub-group and the plant feeding sub-groups of this family, Figure 54 *a* gives a magnified view of the beak of our insect seen from below, and Figure 54 *c* a similarly magnified view of that of a plant-feeder belonging to the same family (*Euschistus punctipes*, Say), which is so nearly of the same size, shape and color as our cannibal friend, that at first sight many persons would mistake one for the other. The Spined Soldier-bug, however, may be at once distinguished from all allied bugs, whether plant feeders or cannibals, by the opaque brown streak at the transparent and glassy tip of its wing-cases.

It has sometimes been reported that the common Squash-bug (*Coreus tristis*, DeGeer) preyed upon the Colorado Potato-beetle; but there can be little doubt but that the Spined Soidier-bug has in these instances been mistaken for it. The colors of the two are somewhat similar but in the eyes of an entomologist the Squash-bug looks as different from the Spined Soldier bug as a cow does from a horse! The figure (55, *a*) of the former which is given above, opposite to that of the latter, will enable any one to recognize the difference, while its magnified beak (Fig. 55, *b*) indicates by its slenderness that it is a plant-feeder.

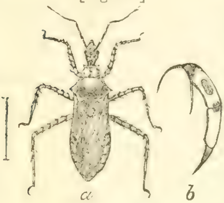
The Spined Soldier-bug by no means confines himself to Potato-beetle larvæ, but attacks a great number of other insects.

[Fig. 56.]

The Bordered Soldier-bug.—This is another insect which attacks the Colorado Potato-beetle. It belongs to the same sub-group, and has the same kind of short robust beak as the preceding, but unlike that species, it is so conspicuously and prettily marked that it cannot easily be confounded with any other. Its colors are dark olive-green and cream-color, marked as in Figure 56. It is not so common as the preceding species.

The Many-banded Robber.—Another true bug, still more elegantly marked than the preceding, (*Harpactor cinctus*, Fabr.,) was observed by Dr. Shimer, of Mt. Carroll, Illinois, to attack the Colorado larvæ, and I found it attacking the same larva in our own State the present year. Like the Spined Soldier-bug, this species is common, and inhabits trees more commonly than herbaceous plants. But it belongs to an entirely different group of the true Bugs (*Reduvius* family), all of which, without exception, are cannibals, and are characterized by a short, robust, curved beak (Fig. 57, *b*, profile view, magnified). Figure 57, *a*, gives a magnified view of this bug, the colors being yellow, white and black, and it may be known by the name of the Many-banded Robber.

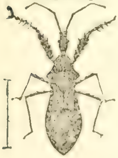
[Fig. 57.]



a *b*

The Rapacious Soldier-bug.—Still another bug belonging to the very same group as the preceding (*Reduvius raptatorius*, Say), I have found sucking out the juices of the Colorado larva, and specimens were sent to me by S. H. Kriedelbaugh, of Clarinda, Iowa, who found it with the same commendable habit in that State. This bug is represented at Figure 58. It is of a light brown color, and may be known by the name of the Rapacious Soldier-bug.

[Fig. 58].



The above four insects are all of them true bugs, and attack the larvæ of the Colorado Potato-beetle with the only offensive weapon that they have—their beak. The four following (Figs. 59 to 62) are all beetles, and are consequently provided with jaws, so that they are able to eat up their victims bodily; and all of them, except the first, which is confined to southerly latitudes, are common throughout the Western States. Most, if not all, of them prey indifferently upon the Colorado larva and the perfect insect produced from it.

[Fig. 59.]

[Fig. 60.]

THE VIRGINIAN TIGER-BEETLE.—This beetle (*Tetracha Virginica*, Hope) is of a dark metallic green color, with brown legs, and the annexed cut (Fig. 59) will enable its recognition without much difficulty.

THE FIERY GROUND-BEETLE.—This beetle (*Calosoma calidum*, Fabr.) has already been treated of on page 89 where its larva is illustrated and termed the "Cut-worm lion." The beetle is of a black color, with coppery dots, as shown in Figure 60, and has also been found to prey on the Colorado larva.

[Fig. 61.]

[Fig 62.]

THE ELONGATE GROUND-BEETLE.—This pretty and conspicuous insect (*Pasimachus elongatus*, *Lec.*) is another enemy of the Colorado Potato-beetle. It is of a polished black color edged with deep blue, and is of a rather elegant form, being represented at Figure 61.

THE MURKY GROUND-BEETLE.—Finally this beetle (*Harpalus caliginosus*, Say) which is of a dull black color, and which is represented life-size at Figure 62, has the same commendable habit as the other three. There are ten or twelve other beetles mostly of small size, which have the same habits as the above; but they would not be readily identified from an uncolored drawing.

BLISTER BEETLES.—Strange as it may seem, the Striped Blister-beetle (Fig. 39, p. 97), and the Ash gray Blister-beetle (Fig. 40, *a*, p. 98), which have already been described as very injurious to the potato, seem to have the redeeming trait of also preying occasionally on the larva of the Colorado Potato-beetle. It was at first difficult to believe or reconcile the statements to this effect which were reported during the summer, but there have been so many of them that the fact may now be considered as indisputable, and these two Blister beetles may therefore, with propriety, be placed in the list of the enemies of the Colorado beetle. I by no means advise their protection, however, on this account; for I believe that what little good they accomplish is much more than outweighed by the injury they do us. As authorities for these statements may be quoted, among many others, Abel Proctor, of Jo Daviess county, Ill., and T. D. Plumb, of Madison, Wis.

"When dog eats dog, then comes the tug of war;"

when rogues fall out, honest men come by their own. And now that certain potato-beetles have taken to feeding upon other potato-beetles, the American farmer may justly lift up his voice and shout for joy.

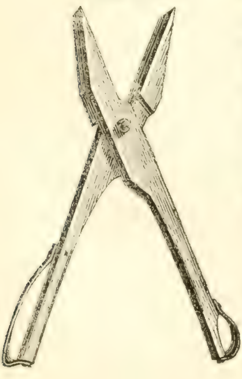
Neither ducks, geese, turkeys nor barn-door fowls will touch the larva of the Colorado-beetle when it is offered to them; and there are numerous authentic cases on record, where persons who have scalded to death quantities of these larvæ, and inhaled the fumes from their bodies have been taken seriously ill, and even been confined to their beds for many days in consequence.

ARTIFICIAL REMEDIES.—It only remains to say something on the most approved method of fighting the Colorado Potato-beetle. A great deal may be effected by raising your potatoes at a point as remote as possible from any ground where potatoes were raised in the preceding year. A great deal may also be accomplished, where there are no other potato patches in the immediate neighborhood, by killing every beetle found upon the vines in the spring, as fast as they emerge from the ground. By this means the evil is nipped in the bud, and a pretty effectual stop is put to the further propagation of the insect. But if there are potato patches near by, where no attention is paid to destroying the beetles, they will keep perpetually flying in upon you in spite of all you can do.

I have already stated that this insect cannot be driven as can the blister beetles, and we have to rely on other measures. I might occupy page after page in detailing the experiments that have been tried by myself and by others. But of all the mixtures recommended I can seriously recommend none. They are impracticable on a large scale, and require too frequent repetition to be efficient, as the beetles issue from the ground day after day. White hellebore, paris green, slaked lime, etc., etc., I have proved by experiment to be valueless, though the two first will kill, if thoroughly applied, a certain proportion of the larvæ, but will not affect the beetles; and even cresylic acid soap, which is the best wash of the kind, does not kill them all. Hot water affects the pests as fatally as any of these applications, and when I state that I have known the beetles to bore through three inches of hard unleached ashes, the folly of *their* application to the vines becomes at once apparent.

I, therefore, again impress upon my readers the importance of prevention by killing every beetle which first appears in the spring. There is no better way of doing this than by crushing them on the spot, and for this purpose a very simple pair of pincers may be constructed. At Figure 63 I represent a pair that were used last summer by S. H. Ford, of Rolling Prairie, Wisconsin, and which were kindly sent to me by L. L. Fairchild of the same place. Their construction is so simple that it needs no explanation, two pieces of wood, a screw, and two small strips of leather being the only things needed.

[Fig. 63.]



In parts of Iowa, the ravages of this insect were so serious in 1866, that a horse-machine was invented for their destruction by Mr. Benson, of Muscatine in that State. As this machine, or some improvement on it, may prove advantageous where potato-growing is carried on extensively, I subjoin an account of it.

"The cost of the machine was about thirty dollars. It consists of a frame-work, which moves astride the row of potatoes, on which is mounted longitudinally a reel somewhat like the one on McCormicks' old Reaper, which knocks the bugs off the plants into a box on one side. This box is of course open on the side next the row nearly down to the ground, but is some two feet high on the outside and at the ends. The reel works over the inner edge of the box, and the bugs are whipped off the vines pretty clean; and the most of them are thrown against the higher side of the box, which converges like a hopper over two four-inch longitudinal rollers at the bottom, between which the bugs are passed and crushed. These rollers are some three or four feet long.

"Those insects which are perched low down on the plants are frequently knocked on to the ground; but I think they would soon crawl up again; and repeating the operation at intervals would very greatly reduce their numbers, and lessen very much the labor of hand-picking, which I think would be advisable in conjunction with the use of the machine, in order to destroy the eggs and diminish the young brood, which is most destructive to the foliage of the plant."

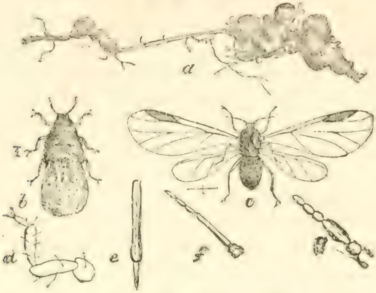
Much may be done by a proper choice of varieties, the Peach-blow having the same immunity from the attacks of this Colorado Potato-beetle, as from those of the Blister-beetles. I have known several instances where Neshannocks, raised side by side with Peach-blows, have been entirely destroyed, while the latter were untouched; and I therefore strongly recommend the planting of Peach-blows in those sections that have been visited by the beetle.

In conclusion let me give another word of caution. Our friends of the Eastern States will, doubtless, in the course of events, become sufficiently acquainted with this beetle. As already stated, it is now in Ohio, and will continue from year to year to spread eastward. Let us, of the West then, not hasten its introduction by our carelessness. Farmers are in the habit of sending insects through the mail to the editors of Eastern papers for identification. Wherever insects are thus sent, they should be thoroughly secured so as to prevent any possible escape. Specimens of this beetle were last year sent to the office of the *American Agriculturist*, in New York, packed in a very insecure manner. Had but a single impregnated female contrived to escape from the package, it might have been the means of prematurely introducing this mischievous pest into that State. A word to the wise is sufficient.

THE APPLE-ROOT PLANT-LOUSE—*Eriosoma* [*pemphigus*] *pyri*, Fitch.

(Homoptera, Aphidæ.)

[Fig. 64.]



The roots of the apple tree are very often found to rot, and thus cause the death of the tree. Of these rots there appear to be three distinct kinds. One kind is that popularly known as "rotten root" in Southern Illinois, and seems to be a simple decomposition of the vegetable tissue, analagous to the rotting of the root of a cabbage for instance. Its cause is not clearly understood, though it seems to be a consequence of certain conditions of the soil. The other rot was discovered the past summer by Dr. Hull, of Alton, Illinois, and is a fungoid growth, which, after covering the root with a thin layer of white fibrous substance, causes a sort of dry rot of the root, and which is common to both the pear and the apple. Some of the symptoms of this rot are: a rather earlier devolopment or maturity of the branches; an excess of fruit buds, and a shortening or thickening of some twigs. Specimens of the affected roots were brought to Dr. T. H. Hilgard, of St. Louis, for experiment, but all that he was able to ascertain was, that it enters the healthy wood in the shape of a brown stringy rot through the canals made by missing fibres.

In a paper read by Dr. Hull, before the Illinois State Horticultural Society, at its 13th annual meeting, a communication was quoted from Judge A. M. Brown, of Villa Ridge, in which the latter gave it as his firm belief that rotten apple tree roots were never caused by root-lice, but by this particular fungus. With due deference to Judge Brown's opinion, I have to differ with him most emphatically, for I am convinced that this Root louse *does cause the roots to rot*. I examined on the 15th of May last, hundreds of young apple trees on the nursery of Mr. J. M. Jordan, of St. Louis. Mr. J. had been greatly troubled with root-lice on his young apple stock during the year 18[illegible]7, and had dug up and thrown thousands of young trees into a heap, by which means he expected to kill the lice and prevent their spreading onto new stock. He covered this heap with earth a foot deep, and had the gratification of finding that nearly all the lice had died by the next spring. Many rows of trees—mostly one year grafted—had been left in the ground, however, and on examining these, I found that wherever the previous year the lice had been numerous enough to cover and deform the whole root, there that root had invariably rotted. In many instances all trace of the knots and deformities which the lice cause, had disappeared, while, in some few instances they were yet traceable. In every case where rot had ensued the lice had entirely left, so that not a trace of them could be found. From these, and subsequent observations made during the summer, I conclude that the rot does not ensue till the roots have been completely deformed by the lice, and while on a young tree a colony of lice will multiply sufficiently to entirely cover it in a single season, and thus cause it to rot the next year; on larger trees they may be at work for years before this result is accomplished. This rot from root-lice may, I think, be distinguished from both the other kinds by its being more porous and soft, approximating the brown mould of a rotting log. The unusual swellings and knots caused by the lice, though hard originally, seem to loose their substance, and very frequently the finer roots, and almost always the fibrous roots waste entirely away.

The diagnosis of either of the first two kinds of rot must remain hidden, until our knowledge of these impalpable funguses shall have become more thorough, and until then no remedy can be suggested; but with the last kind, having traced it to its true cause, the means of prevention are at hand, and I will now give the history and description of the Apple-root Plant-louse for the most part as it appeared in the AMERICAN ENTOMOLOGIST for January, 1869:

For the last twenty years a Wooly Plant-louse has been known to infest the roots of the apple-tree, causing thereon swellings and deformations of almost every possible shape, and, when very numerous, killing the tree. In the more northerly parts of the Northern States this insect is comparatively rare, but in southerly latitudes it is exceedingly destructive in apple orchards. According to Dr. Hull, "it is one of the worst enemies against which our apple-trees have to contend, and is much more common in our region than is generally supposed." (*Agr. Rep*, *Mo.*, *Append.*, p. 451.) As long ago as 1848, Mr. Fulton, of Chester county, Pennsylvania, found this root-louse and the knotty swellings produced by it to be so abundant on nursery-trees in his neighborhood, that thousands of young trees had to be thrown away, and it became difficult to supply the market.) Downing's *Horticulturist*, III, p. 394.) And in August, 1858, M. L. Dunlap (*Rural*) stated in the *Chicago Tribune*, that in an orchard near Alton "the Wooly Aphis infests the roots in immense numbers, and by sucking up the sap destroys the trees, which in its effect has much the appearance of dry rot."

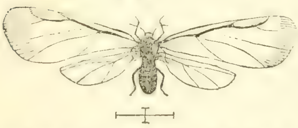
Although this insect usually confines itself to the roots of the tree, yet a few may occasionally be found on the suckers that spring up round the butt of the trunk, and even on the trunk and limbs, especially in places where a branch has been formerly amputated, and nature is closing up the old wound by a circle of new bark. Where it works upon the naked trunk, it often causes a mass of little granulations to sprout out, about the size of cabbage-seeds, thus producing on a small scale, the same effects that it does upon the roots. Wherever the insect works, small as it is, it may be easily recognized by the peculiar bluish-white cottony matter which it secretes from its body, and which is never met with in the case of the common Apple-tree Plant-louse that inhabits the leaves and the tips of the twigs.

Figure 64 at the head of this article, fully illustrates the Apple-root Plant-louse. A portion of a knotty root as it appears after the punctures of the lice is represented at *a*, the larva state at *b*, and the winged state at *c*; while *d* represents the leg, *e* the proboscis, *f* the antenna of the winged individual, and *g* that of the larva, all highly magnified. The young louse is of a deep flesh or pink color, and the proboscis extends the whole length of the body, while the older specimens have a deeper, purplish hue. Of the winged louse, I subjoin a more complete description.

ERIOSOMA PYRI, Fitch—Color black. Antennæ 2-5ths as long as the body, joints 1 and 2 almost confluent, short and robust; joint 3 fully ½ the entire length of the antennæ; joints 4—6 subequal, 5 a little the longest, 6 a little the shortest. Meso-thorax polished. Abdomen opaque with more or less pruinescence. Legs opaque black, immaculate. Wings hyaline; costal and subcostal veins robust and black; stigma pale brown, 2¾ to 3 times as long as wide, pointed at both ends, but more acutely so on the basal end, the vein bounding it behind robust and black. Discoidal veins and stigmal vein slender and black, the 3d or forked discoidal hyaline and subobsolete on its basal ⅓. Length to tip of closed wings 0.13—0.14 inch.

On comparing Figure 64 *c* with Figure 65, which represents a Plant-louse that inhabits a large gall on the Cottonwood, it will be observed at once that the veining of the front wing is very different. In Figure 64, *c*, the third branch-vein is very distinctly forked; in Figure 65 it is simple. Nor is this a mere accidental variation, but a peculiarity of the genus to which either insect belongs. (Fig. 64, *c*, genus *Eriosoma*; Fig. 65, genus *Pemphigus*). Now Dr. Fitch describes and names the Apple-root Plant-louse as belonging to the latter genus (*Pemphigus*); whereas winged specimens which both Mr. Walsh and myself obtained last October, at Duquoin, from apple roots and suckers swarming with larvæ; some which I received from St. Louis county, and others which Mr. Walsh bred from larvæ; all, without exception, belong to the former genus (*Eriosoma*). And moreover, Dr. Fitch's insect is described as being nearly twice as large as ours. How does this come about? We can only account for it in the following way: Dr. Fitch's winged specimens were but two in number, and they were found by him, the one living, the other dead, upon the roots of an infested young apple-tree, which had been brought him from an adjoining county. Hence he very naturally, but as we think erroneously, infer-

[Fig. 65.]

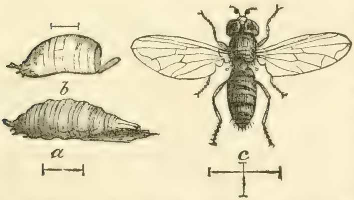


red that these two winged plant-lice belonged to the same species as the minute wingless larvæ with which the infested roots were swarming. The truth of the matter probably was, that the two winged plant-lice got upon the infested apple-root by accident, on their road from the nursery to Dr. Fitch's orchard. Indeed we can almost say with certainty to what species they belonged; for on comparing Dr. Fitch's very minute and elaborate description with the Beech-twig Plant-louse (*Pemphigus imbricator*, Fitch), which comes out in the winged state in the very same time of the year as he met with his two specimens, it agrees sufficiently well to apply to that species. If, on the other hand, we compare his description with our specimens, it not only disagrees generically, as already explained, but neither the size nor the markings will correspond at all.

We consider it, therefore, to be sufficiently certain that the Apple-root Plant-louse does not belong to the genus (*Pemphigus*), to which all subsequent authors, in deference to Dr. Fitch's authority, have hitherto referred it, but to the very distinct genus (*Eriosoma*) to which the notorious Wooly Plant-louse of Europe belongs (*Eriosoma lanigera*, Hausm.)

Natural Remedies.—From the enormous rate at which all Plant-lice multiply, it is plain that, if there were no check upon the increase of the Apple-root Plant-louse, it would in a few years' time sweep away whole orchards, especially in southern latitudes. Luckily for the fruit growers and fruit-lovers, there exist two at all events, and probably three such checks. The first is a very minute parasitic fly, which Prof. Haldeman figured and described in 1851 as infesting in the larva state his supposed Wooly Plant-louse.* The second is a footless maggot (Fig. 66 *a*) about one-half an inch long, and of a dirty yellow color. It is generally found more or less covered with mud, and with the woolly matter secreted by the lice, and is not by any means easily discerned. It changes in the fall to the pupa state (Fig. 66, *b*) from which, in the following spring, there emerges the perfect fly (Fig. 66, *c*) which may be known as the Root-louse Syrphus-fly. The following is the description of this fly, in its different stages, which appeared in the American Entomologist.

[Fig. 66.]



The Root-louse Syrphus-Fly. (*Pipiza radicum*, n. sp.) ♀ Shining brown black. *Head* clothed with short, rather sparse, white hairs, especially the lower part of the anterior orbits and the entire space below the antennæ. Mouth dark rufous. Antennæ compressed, with the joints proportioned as 2, 2, 5; joint 2 twice as wide as 1, and 3 twice as wide as 2; of a dull rufous color, edged above, narrowly on the inside, widely on the outside, with brown black. *Thorax* very finely rugoso-punctate, with some short sparse white hairs, especially laterally. *Abdomen* finely punctate,

* This fly belongs to the *Chalcis* family in the Order *Hymenoptera*, and was named *Eriophilus mali* by Prof. Haldeman. The figure and description will be found in the *Farm Journal* for 1851, pp. 130-1.

with longer white hairs, rufo-piceous above on the middle ⅓ of joint 1; venter with joint 1 piceous. *Legs* with all the 6 knees, and in the 4 front legs the entire tibia except a spot on the exterior middle, and also all the 6 tarsi except their extreme tips, and except in the hind legs the basal ⅔ of the first tarsal joint, all dull pale rufous. *Wings* hyaline; veins black. Length ♀ 0.25 inch; alar expanse 0.48 inch.

One ♀; ♂ unknown. Bred May 23 from a single puparium found in the November preceding. On May 2 this puparium, which in the preceding autumn had been lightly covered with moist sand and deposited in a cellar, had crawled up out of the sand a distance of two inches, and attached itself to the stopper of the bottle in which it was inclosed. Upon being replaced under the moist sand, it was found two days afterwards to have again crawled about an inch up the side of the bottle. We have observed the same locomotive powers in the puparia of several other Syrphidous insects, though, so far as we are aware, this very anomalous faculty has not hitherto been commented on by authors.

We are indebted to Dr. LeBaron, of Geneva, Ills., who has paid special attention to the Order (*Diptera*) to which this insect belongs, for determining the genus to which it is properly referable. According to him, "the genus *Pipiza* differs from *Syrphus* in the absence of the prominence in the middle of the face, in the comparatively greater development of the posterior legs, and in the want of the little spurious longitudinal vein in the middle of the wing." "The only species discovered by Macquart," he adds, "is from Carolina, and very different from yours."

Larva.—Dull pale flesh-color, tinged with yellow. Attenuated and somewhat depressed anteriorly; more blunt posteriorly, the anal segment being furnished with an elevated tube, which is of a light polished brown at extremity. Wrinkled transversely, with a prominent fold at anterior and posterior edge of each segment. The larger segments well defined; the smaller ones less so. First segment thoroughly retractile, and sufficiently translucent when extended, to show the dark triple-jointed mouth. A few soft, fleshy spines, of the same color as the body, and especially distinct on anal segments. Generally covered and disguised by the soil which it inhabits. Length when not extended, 0.23 of an inch. Described from two specimens taken in 1866 and three in 1868.

Pupa.—Dull dirty yellow. Gradually formed by the contraction of the larva, during which time the wrinkles are obliterated, and it at last becomes quite smooth. Length 0.18.

I first found this larva in December, 1866, at Cobden, Ills., and have found it at several different times since, and though I failed to breed any to the perfect state, Mr. Walsh was more fortunate. Wonderful indeed must be that instinct, which enables the mother-fly to perceive which particular trees in an orchard have their roots swarming with lice, so as to know exactly where to deposit her eggs!

The third insect which preys upon these Root plant-lice, at least in Missouri, is a small species of ladybird, belonging to the genus *Scymnus.* The larva of this beetle is still more difficult to recognize among the lice, as it is covered on the back with little tufts of wooly matter, secreted from its own body. It is, when full grown, somewhat larger than the lice, and altogether more active, and is distinguished furthermore, by the wooly matter being of an even length and distributed over the back in transverse rows. Mr. J. F. Waters, of Springfield, Missouri, sent to me a number of the apple root-lice, with some of these little ladybird larvæ among them, which he erroneously supposed to be the old lice. In due time I bred the perfect beetle from them, and it proved to be a species which the French entomologist Mulsant, had described as *Scymnus cervicalis.* It is a very inconspicuous little beetle, about 0.05 of an inch long, and of a deep brown color, the thorax being of a lighter brown. From subsequent correspondence with Mr. Waters I learned that the lice upon which these little friends of ours were preying, were taken right from the surface of the ground, so that it is possible that this ladybird only attacks them when it can get at them above ground; though, judging from analogy, I strongly suspect it also seeks them out in their underground quarters.

Artificial Remedies.—The best mode to get rid of the Apple root Plant-louse is to drench the roots of the infested tree with hot water. But to render this process effectual, the water must be applied in quantities large enough to penetrate to every part of the infested roots. There need be no fear of any injurious result from such an application of hot water; for it is a very general rule that vegetable organisms can, for a short time, stand a much higher temperature than animal organisms, without any injury to their tissues. In laying bare the roots for the better application of the water, a sharp eye should be kept for the friends above described, and when espied they should be tenderly laid aside till after the slaughter of the enemy. Mulching around the infested trees has been found, by Mr. E. A. Riehl and others, of Alton, Illinois, to have the effect of bringing the lice to the surface of the ground, where they can be more easily reached by the hot water.

THE WOOLY ELM-TREE LOUSE—*Eriosoma ulmi*, N. Sp.

(Homoptera Aphidæ.)

The White elm is subject to the attacks of a woolly plant-louse belonging to the very same genus as the preceding. This insect appears to be quite common in our State as well as in Illinois, for I have known several elm-trees on Van Buren street in the city of Chicago, to be killed by it, and every tree of this description, around the court house in St. Louis was more or less affected with it last summer. The lice congregate in clusters on the limbs and the trunks, and cause a knotty unnatural growth of the wood, somewhat similar to the knots produced on the roots of the apple-tree by the other species. They are mostly found sunk in between the crevices formed by these knots, and the punctures of their little beaks cause the sap to exude in the shape of little silvery globules, which may generally be found dispersed among the knots. The down or wooly matter is secreted by them from all parts of the body, but especially from the posterior part of the back. It is of an intense white color, and is secreted in such profusion that it usually covers and hides the lice, and when they are numerous, gives the limbs from a distance the appearance of being covered with snow. They make their appearance during the latter part of May, and by the latter part of June the winged individuals may be found mixed up with the larvæ and pupæ. I have experimentally found that a washing with a weak solution of cresylic acid soap will kill them all instantly, and they are thus easily exterminated. They are also preyed upon unmercifully by the larvæ of an undescribed species of Lacewing fly (*Chrysopa eriosoma* of my MS.).

ERIOSOMA ULMI, N. Sp.—Color dark blue. Length to tip of closed wings, exclusive of antennæ, 0.12. Wings hyaline, three times as long as wide, and more pointed at the ends than in *E. pyri.* Costal and subcostal veins, and that bounding the stigma behind, robust and black. Discoidal veins together with the 3d forked and stigmal veins, all slender and black, the forked vein being as distinct to its base as are the others, with the fork but ⅓ as long as the vein itself and curved in an opposite direction to the stigmal vein. Antennæ 6-jointed and of the same color as the body; joints 1, 2, 4, 5 and 6 of about equal length, joint 3 thrice as long as either. Legs of the same color as body.

The young lice are narrower and usually lighter colored than the mature individuals, varying from flesh or pink to various shades of blue and purple.

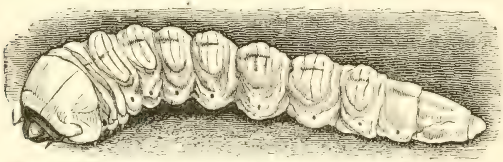
INSECTS INJURIOUS TO THE GRAPE-VINE.

The culture of the grape forms an important branch of Missouri horticulture. There is scarcely another State in the Union that has such natural advantages for the growing of this delicious fruit. While traveling up the Missouri river, I have been struck with the great similarity in the general character of the country to the celebrated Grape-growing districts of the Rhine, in Prussia. The Germans have also so thoroughly settled the country along the Missouri that the resemblance is made still more striking. As another evidence of the importance of this branch of horticulture in our State, the *American Grape Culturist*, the only periodical published in this country that is solely devoted to Grape-growing and wine-making, has just been started in St. Louis, by Mr. George Husmann. It becomes us then to know something of the insects injurious to the vine.

THE NEW GRAPE-ROOT BORER—*Orthosoma cylindricum*, (?) Fabr.

(Coleoptera, Prionidæ.)

[Fig. 67.]



The *ad interim* committees of the Illinois and Missouri State Horticultural Societies, while visiting the orchards and vineyards along the line of the Iron Mountain Railroad, discovered that sundry grape vines on Dr. C. W. Spaulding's place were dying; and on digging up such vines, the roots were found to be entirely hollowed out, and in many instances severed, by a worm which is faithfully represented at the head of this article—Figure 67. At about the same time, Mr. Walsh, of Rock Island, received an immense specimen from W. D. F. Lummis, of Makanda, Illinois, with the same account of its habits, and the following letters which I have since received relate to the same worm:

MR. RILEY—*Dear Sir:* Herewith please find a worm or grub, which has bothered my grape vines, it cuts the vine off about 3 or 4 inches under ground and takes out about an inch. Set vines last spring. Put stakes of oak, green.

Respectfully, &c.,

ALFRED BARTER.

VIRGIL CITY, Mo., August 21, 1868.

PROF. RILEY, *State Entomologist:* I leave here for you a specimen of a worm which has proved very destructive in my vineyard this season having killed 24 vines, usually commencing at the bottom eye and eating the entire stem almost to the surface of the ground. I have dug up all the vines and in each case have found but one worm sometimes as deep as 18 inches below the surface. My vineyard was planted this spring on ground previously cultivated; has been thoroughly subsoiled and is well drained; the vines are Hartford Prolifics aud Concords. Please send any information ot value you may have relating to the above to Col. John H. Hogan, Pevely Station, I. M. R. R.

Very respectfully,

JOHN H. HOGAN.

September 3, 1868.

MR. RILEY *Dear Sir:* The Grape-vine borer has been quite destructive in our vineyard this season, having killed 15 vines. Except in two cases we found and dispatched him without mercy. We first noticed the effects of the borer about the latter part of July and frequently found them until the latter part of August. In some instances we found the root severed within ½ half an inch of the surface, while the borer was found at the bottom of the root. In others the root was eaten off from 5 to 8 inches below the surface. Only Concord vines have been affected, and only those that we obtained from a neighboring vineyard for planting last spring. Not one of our original vines have been destroyed, though we have 4 acres equally exposed to the attacks of this new destroyer. Any information that you may be able to give us upon this subject will be thankfully received.

Very respectfully,

SIMMONS & TILLSON.

SULPHUR SPRINGS, September 10, 1868.

Mr. D. C. Peebles, D. D. S., of St. Louis, also brought me a large Concord vine that had been entirely severed from the roots and killed by this worm, and I also received specimens about ¼ grown from T. W. Guy, of Glenwood.

The above letters convey a very good idea of the manner in which this borer works. It seems to have occurred in the Concord vines more generally than in those of any other variety, but I think that this may be attributed to the fact that more Concords are planted than any other kind, for as the following facts will show the borer is evidently a very general feeder. In the early part of June, 1867, Mr

O. B. Galusha, who was then with the *ad interim* committee visiting Southern Illinois, sent me a worm in all respects similar which was found boring into the root of an apple tree. I have also received Osage orange roots from Kansas which were being bored by the same fellow, and he is evidently partial to rotten oak stumps for not only have several persons who are well able to judge, assured me that they have found him in such stumps, but Mr. A. Bolter, of Chicago, also found it in such stumps in Kentucky, and sent me the specimens for identification. At the meeting of our State Society, at Columbia, Mr. J. N. Stuart even avowed that he had found it partly grown, not only in seedling apples but in the roots of corn stalks, while Chas. Connon, of Webster, assures me that he has found it in the heart of felled hickory, and I ascertained that he was perfectly capable of distinguishing it from the common borer (*Cerasphorus cinctus*, Drury), which infests hickory when felled, and which causes what is known as "powder post," he being quite familiar with this last named insect. There are several large beetles in the West which must have larvæ very similar in appearance to this, and it is not at all unlikely that different insects have here been confounded, but the figure at the head of this article, with the following description of this Grape-Root borer, will enable any one to recognize it in the future.

LARVA OF ORTHOSOMA CYLINDRICUM, (?) Fabr.—Average length when full grown, 3 inches. Color pale yellowish white, partly translucent, with glaucous and bluish shadings, and a distinct dorsal line of the last color. Segment 1 rather horny, rather longer than 2, 3 and 4 together, broadening posteriorly, slightly shargreened and whiter than the rest of the body, with a rust-colored mark anteriorly. Segments 2 and 3 shortest and broadest, the body tapering thence gradually to extremity, though there is usually a lateral ridge on segment 12 which dilates it rather more than the segments immediately preceding it. This segment 12 is also the longest, the terminal one being quite small and divided into three nearly equal lobes. A swelled hump crossed with two impressed transverse lines, on segments 4, 5, 6, 7, 8, 9 and 10. Stigmata rust-colored, 9 in number, the first and largest being placed on a fold in the suture between segments 1 and 2. Head brown, verging to black on anterior edge. Mandibles large, strong, black, with one blunt rounded tooth, giving them a somewhat triangular appearance; antennæ 3-jointed and brown, especially at tip; labrum fulvous, fuzzy and with a brown base; maxillary palpi 4-jointed, the basal joint much swollen, the terminal joint brown, and a ring of the same color at sutures of the other joints; labial palpi 3-jointed, the basal joint also swollen, and the terminal joint and sutures of the others brown. Six rudimentary 2-jointed fuscous feet as shown at Figure 68. Venter tubercled as on the back, these tubercles being especially prominent on segments 6, 7, 8 and 9, where they recall prolegs. The young larva differs only in lacking the rust-colored mark on segment 1.

[Fig. 68.]

Now, to what insect does this borer belong? It is manifestly the larva of some long-horned beetle of the family PRIONIDÆ, but of what particular species cannot be positively stated till the beetle is reared from grape-root-boring larvæ. Before another year shall have passed away, I hope to definitely determine this point, but meanwhile, I have every confidence that it will produce the Cylindrical Orthosoma (*Or-*

[Fig. 69.]

thosoma cylindricum, Fabr.), a large flattened, long-horned light bay-colored beetle which is common throughout the country and especially in the Mississippi valley, and which is represented of the natural size at Figure 69. True, according to Westwood, the larvæ of the PRIONIDÆ have the second segment enlarged and broadened, while the closely allied family CERAMBYCIDÆ, has the first segment thus enlarged as in our insect; but from a larva resembling ours in every respect so far as his description goes, and which he found in September, 1867, in decaying pine wood, Mr. Walsh actually bred, about the last of June, 1868, the Cylindrical Orthosoma. The only accounts on record which pretend to give the natural history of this beetle, are by Dr. Fitch and S. S. Rathvon, that of the former in his 4th Report, § 239, and that of the latter in the Agricultural Reportfor 1861, pp. 611–612. Dr. Fitch describes the larva, which he supposed belonged to this beetle, but which he did not breed, as occurring in pine trees, and as having the first ring longest and the second broadest; while Mr. Rathvon figures it with the first ring infinitely shorter than the second, but confesses that the drawing was made from memory, and he doubtless trusted to the authority of Westwood. Furthermore Monsieur E. Perris has figured at Plate 6, Figure 362, of the "Annales de la Société Entomologique de France," for 1856, the larva of *Prionus obscurus*, Oliv. which bores into the pine and which very closely resembles our larva, the first and not the second segment being enlarged.

Until the past summer nothing had been published about the attacks of this insect on Grape roots, and yet upon inquiry I find that it has been known for several years. Mr. Spaulding informs me that the first that was seen of it in his neighborhood was in 1866, when his man found an enormous one in a wild vine which he was about to graft; but Mr. Geo. Husmann, of Hermann, has been acquainted with it since 1850, and has known it to occur around Hermann since 1854. Indeed Mr. Husmann informs me that he has never observed the old Grape-vine Borer which has 16 legs and which produces a moth (*Ægeria polistiformis*, Harris) but that in speaking of the Grape-root Borer he has always referred to this species. Mr. J. H. Tice found it in apple roots in 1860 on the place of James Sappington of St. Louis, while the following item by A. J. H., of Vineland, N. J., which appeared in the January (1869) number of the *Gardener's Monthly*, would indicate that it has the same habit all over the country:

"On page 354 October number of *Agriculturist*, reference is made to a "vine borer" in Missouri that cuts off vines below the surface. It is also mentioned and partially described in the last *Gardener's*

Monthly. This "borer" is an old friend (?) of mine. It is found principally in old rotten oak stumps; I hardly ever dig one out without finding several of these worms. They are about two inches long, tapering from head to tail, white bodies and black heads. I lose on an average about 50 vines and dwarf pears annually by these little villains; probably twice as many pears as vines. I have had several apple trees cut off by them, and one standard pear. The tree roots seem often to be eaten entirely up, but the vine roots are only cut through as if they had obstructed the line of travel.

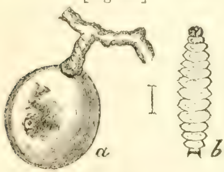
This is no new insect, but will I think probably be found troublesome whenever dwarf pears and vines are planted among decayed oak stumps."

Remedies.—Little can be done in the way of extirpating these underground borers, when, as in the present instance, their presence is only indicated by the approaching death of the vine. Still, every vineyardist should make it a rule to search for them wherever they find vines suddenly dying from any cause unknown to them, and upon finding such a borer should at once put an end to his existence. The beetle which may frequently be found during the summer months, should also be ruthlessly sacrificed wherever met with. I should also advise not to plant a vineyard on land covered with old oak stumps, and not to use oak stakes where those made of cedar can be had as conveniently.

THE GRAPE CURCULIO—*Cœliodes inæqualis*, Say.

(Celeoptera, Curculionidæ.)

[Fig. 70.]



The larva of this Curculio infests the grapes during the months of June and July, causing a little black hole in the skin, and usually a disfigurement and discoloration of the berry, immediately around it as in Figure 70, *a*. The larva (Fig. 70, *b*) is whitish as long as the berry is green, but generally partakes of the color of the berry as it matures. It is footless and like the larvæ of all snout-beetles is incapable of spinning a web. In 1867 I found this insect quite common in Southern Illinois, and as will be seen from the excellent account of it given by Mr. Walsh in his first report, it was very common in the States of Illinois, Ohio and Kentucky, and it also occurred in our own State, as I am informed by Mr. Peabody. From the middle to the last of July, this larva leaves the berry and buries itself a few inches in the ground. Here it changes to a pupa within a small, smooth earthen cavity, and by the beginning of September the above named beetle issues from the ground, and doubtless passes the winter in the beetle state, ready to puncture the grapes again the following May or June. This beetle is

[Fig. 71.]

small and inconspicuous, being of a black color with a grayish tint. It is represented enlarged at Figure 71, the hair line underneath showing the natural size. It is distinguished from all other curculios that are known to attack our fruits by having a rectangular thorn or tooth on the upper and outer edge of the four front shanks (*tibiæ*) as shown at Figure 72; this character being peculiar to the genus (*Cœliodes*) to which it belongs.

[Fig. 72.]

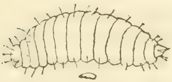
Strange as it may seem, in 1868 there seems to have been an almost entire immunity from this Grape curculio, for I have neither met with it in a single instance, nor heard of its occurrence. No doubt this immunity has been caused principally by parasites, for I failed entirely to breed the perfect Curculio in 1867, on account of some small Ichneumon which killed the larva as soon as the latter had entered the earth, and spun for itself a tough silken cocoon in the place where the Curculio larva, if unmolested, would have undergone its transformations. It is thus that Nature works; "eat and be eaten, kill and be killed," is one of her universal laws, and we can never say with surety that because a particular insect is numerous one year, therefore it will be so the next!

THE GRAPE-SEED CURCULIO.

(Coleoptera, Curculionidæ.)

A minute maggot was discovered last August infesting the seeds of the Grape in certain parts of Canada, by Mr. Wm. Saunders, of London. It causes the berries to shrivel up and utterly ruins them. Specimens which had been received from Canada, were sent to me by my friend A. S. Fuller, of New Jersey, and the annexed Figure 73

[Fig. 73.]



shows a highly magnified view of the maggot, its natural size being represented underneath. The head is of the same translucent, milk-white color as the body, but the jaws, which are finely pointed, are light brown, and there is a patch of brown at their base. It has exactly thirteen segments exclusive of the head, and every segment has a few white, fleshy hairs, these hairs being thickest near the head and longest on the under part of the first three segments, thus imitating feet, as is often the case with footless larvæ of this character.

It is evidently the larva of some curculio, and though it is not yet known to occur in the States, I append the following account of it from Mr. Saunders himself, for the benefit of our Grape-growers:*

* This account is taken from a paper published by Mr. Saunders in the "Report of the Commissioner of Agriculture and Arts of the Province of Ontario," for 1868—pp. 203–5.

"On the 20th of August last we observed that many of the berries in the bunches of a Clinton vine under our care were shriveling up. On opening the grapes, we observed that most of the smaller berries —that is those which had shriveled earliest—contained only one seed, and that of an unusually large size. Some of the larger shriveled grapes contained two seeds, much swollen, each having a dark spot somewhere on their surface. On cutting the seeds carefully open, the kernel was found almost entirely consumed, and the cavity occupied by a small milk-white footless grub with a pair of brown hooked mandibles, a smooth and glossy skin with a few very fine short white hairs. When at rest it is nearly oval in form, but when in motion its body is elongated, varying in length from one-fifteenth to one-twelfth of an inch. * * *

"The Clinton vine on which this pest was first discovered suffered considerably, fully ten per cent. of the crop was lost from the shriveling of affected berries. At first we supposed that the work of the insect was confined to berries of this appearance, and that by destroying these the destruction of the crop of insects for the season would be complete, but further examination showed that many of the ripe berries contained affected seeds. The proportion thus affected on the vine referred to was about ten or eleven per cent. Within a few feet of this vine an Isabella was fruiting; on this there were no shriveled berries, but about three per cent. of those which had ripened were injured. About the same distance in another direction was a Hartford Prolific, and about ten feet further off a Concord, both of which fruited well. On neither af these were there any shriveled berries, nor could we find any affected seeds among those which had ripened. The fruit of a Delaware, about fifty feet distant from the Clinton, was also examined without discovering any traces of the insect.

"About the middle of September we visited the grounds of Mr. Charles Arnold, of Paris, and there we found that this insect had prevailed to a greater extent than it had with ourselves, affecting the Clinton, Delaware, one of Rogers' Hybrids, and also Mr. Arnold's new seedlings. In Hamilton, in the garden of Mr. W. H. Mills, we found an affected seed in a berry of Rogers' No. 4. On the 24th of September we visited the vineyard of the Vine Growers' Association at Cooksville, but could not find any traces of the insect there. Thus far its depredations are most apparent about London and Paris, but probably further examination will show that it is widely distributed.

"Where any shriveled berries are found their seeds should be carefully opened and examined, as it is important to know how far the insect prevails. The affected berries are usually swollen, somewhat soft, and have a dark spot somewhere on their surface; any of this character observed among the ripe berries should also be examined.

"In the case of the shriveled berries, where one seed only is affected, the others are dwarfed and imperfect; and where two large seeds are found they are both occupied. Where one seed only is affected and the other remains healthy, the one normal seed carries the berry through in an apparently healthy state to ripeness. As far as our experience goes the Clinton and its allies with thin skins are more liable to attack than berries with thicker skins, such as Hartford Prolific and Concord.

THE GRAPE-CANE GALL-CURCULIO, *Madarus vitis*, New Species

(Coleoptera, Curculionidæ.)

The canes of the Concord vine are frequently found to have galls on the last year's growth, in the shape of an elongated knot or swelling which is generally situated immediately above or below a joint. This gall was formed the previous fall while the tender cane was growing, and has almost invariably a longitudinal slit or depression on one side, dividing that side into two cheeks, which generally have a rosy tint. The gall is caused by a little footless, white cylindrical larva which measures 0.28 of an inch, and has a yellowish head, and somewhat darker tawny jaws. It is minutely wrinkled transversely, and sparsely covered with minute white bristles; the three segments next to the head being prominently swollen underneath and the bristles attached to them look very much like legs, and doubtless to some extent perform the functions of legs. This larva indeed bears a very close general resemblance to that of the Potato Stalk-weevil, illustrated at page 93, Figure 37 *a*, and when taken out of its gall immediately curls up as in that figure. During the latter part of June this larva transforms within the cane to a pupa, also greatly resembling that figured at *b*, on page 93, with the exception that it is much smaller, and that the wings and legs reach down three-fourths the length of the body instead of but one-half as in that species. Two weeks after it has thus transformed it becomes a beetle belonging to

[Fig. 74.]

the great Curculio family. Before this insect had ever been bred to the perfect state I predicted that it would produce a Curculio, as may be seen by referring to page 117 of the Transactions of the Illinois State Horticultural Society for 1867. This beetle is represented enlarged at Figure 74, its natural length being 0.10. It is of a uniform light yellowish-brown without any markings whatever. It is closely allied to the Potato Stalk-weevil, but belongs to the genus *Madarus* which differs from *Baridius* in the peculiar undulating appearance of the wing-cases, and more especially in their being highly polished, the word *Madarus* meaning glossy or polished. This little

Curculio was considered a new species by Dr. Le Conte, in 1861, and as it has not, so far as I am aware, been described since that time, I subjoin a more complete description of it:

MADARUS VITIS, N. Sp.—Length, exclusive of rostrum 0.10. Color uniformly rufous, without maculations, the eyes alone being darker. Highly polished; rostrum arcuated, stout and about as long as thorax; thorax and body with extremely minute and distant punctures, anterior margin of thorax abruptly narrowed, especially laterally, into a collar; elytra slightly undulate, with 4 distinct elevations, one on the extreme outer margin close to the thorax, and one on the middle of each, near the extremity.

As an illustration of the great similarity in the habits of insects belonging to the same genus, I will state that there is a small black Curculio, belonging to the genus *Madarus* and differing from this Grape-cane Gall-curculio in no other respect but in color, whose larva lives in a somewhat similar gall found on the common creeper (*Ampelopsis quinquefolia*) which is very closely related to the vine. This black species is also undescribed and is marked *Madarus ampelopsis* in Mr. Walsh's collection.

I think it highly probable that the gall of the Grape-cane Curculio is caused more by the punctures which the female beetle makes in depositing her egg, than by the irritations of the larva: for I have found the larva where it had burrowed two and three inches up the cane, away from the gall, without its having caused a corresponding swelling; though this has always been in the one-year-old cane.

REMEDY.—If these gall-bearing canes are cut off and burned during the winter there need be little fear of this insect's work, the more especially as it is not secure from parasites, even in its snug retreat, for I have bred a species of *Chalcis* fly from the galls, which had evidently destroyed the true gall-maker.

THE GRAPE-VINE FIDIA—*Fidia viticida*, Walsh.

(Coleoptera, Chrysomelidæ.)

One of the worst foes to the grape-vine that we have in Missouri is the Grape-vine Fidia which is represented in the annexed Figure 75.

[Fig. 75.]

It is of a chestnut-brown color, and is densly covered with short and dense whitish hairs which give it a hoary appearance. I have found it very thick in most of the vineyards which I visited, and it is almost universally miscalled the "Rose-bug," which is, however, a very different insect. The Grape-vine Fidia was first described by Mr. Walsh in the May, 1867, number of the *Practical Entomologist.* It is found in the woods on the wild grape-vine and also on the leaves of the *Cercis Canadensis;* but of the tame vines it seems to prefer the Norton's Virginia and Concord. It makes its appearance during the month of June, and by the end of July has generally disappeared, from which fact we may infer that there is but one brood each year. The manner in which it injures the vine is by cutting straight elongated holes of about ⅛ inch in diameter in the leaves, and when numerous it so riddles the leaves as to reduce them to mere shreds. The preparatory stages of this beetle are not yet known.

REMEDIES.—Luckily this beetle has the same precautionary habit of dropping to the ground, upon the slightest disturbance, as has the Plum curculio, and this habit enables us readily to keep it in check. The most efficient way of doing this is by the aid of chickens. Mr. Peschell, of Hermann, on whose vines this beetle had been exceedingly numerous, raised a large brood of chickens in 1867, and had them so well trained that all he had to do was to start them in the vineyard with a boy in front to shake the vines, and he himself behind the chicks. They picked up every beetle which fell to the ground, and in this manner he kept his vines so clean that he could scarcely find a single beetle in 1868.

THE GRAPE CODLING, *Penthina vitivorana*, Packard.—Plate 2, Figs. 29 and 30.

(Lepidoptera, Tortricidæ.)

Although the preceding insect has been so scarce in 1868, yet the Grape has been worked upon in a somewhat similar manner, and even to a greater extent, by the insect now under consideration. Indeed there is very little doubt that Mr. Walsh, not being acquainted with this insect, confounded its work with that of the Grape-curculio, in some of the instances, of the damage done by this last, which are quoted by him in his report, and this is especially the case in the instance of Mr. M. C. Read of Hudson, Ohio.

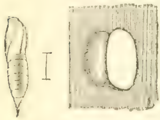
I first received this insect, with an account of its workings, from Huron Burt, of Williamsburg, and subsequently during the month of July, found it universal in the vineyards along the lines of the Pacific and Iron Mountain Railroads. It was found equally common around Alton in Illinois, while Dr. Hull informs me that it ruined 50 per cent. of the grapes around Cleveland, Ohio, the Concord and Ives Seedling being the only varieties which appeared to resist its attacks. It also occurs in Pennsylvania, judging from articles which appeared in the November and December numbers of the *Practical Farmer*. In these numbers my esteemed correspondent, Mr. S. S. Rathvon, of Lancaster, Pennsylvania, gives an account, with description, of some worms which were sent to him by the editors, answering in every respect to this Grape codling. Concluding, from its similarity to the common Apple-worm, that the insect belonged to the genus *Carpocapsa*, he proposed for it the name of *Carpocapsa vitisella*, without having bred the parent moth. In the June number of the *American*

Naturalist (p. 220) is quoted an account of it by Mr. M. C. Read, of Hudson, Ohio, who says that it is "already so abundant there that it is necessary to examine every bunch of ripe grapes, and clip out the infested berries before sending them to the table."

The larva of this Grape-codling may at once be distinguished from that of the Grape curculio, by its having 6 scaly legs near the head, 8 fleshy legs in the middle, and 2 at the extremity of the body, and by spinning a fine web, by which it lets itself drop whenever handled. It is also larger, of a darker color, and bears a very close resemblance to that of the Strawberry leaf-roller, to be hereafter figured and described.

Its presence is soon indicated by a reddish-brown color on that side of the yet green grape which it enters. On opening the grape, a winding channel is seen in the pulp, and a minute white worm with a dark head is seen at the end of the channel. It continues to feed upon the pulp of the fruit, and when it reaches the seeds, eats out their interior. As it matures it becomes darker, being either of an olive-green or dark brown color, with a honey-yellow head, and if one grape is not sufficient it fastens the already ruined grape to an adjoining one by means of silken threads, and proceeds to burrow in it as it did in the first. When full grown it leaves the grape and forms its cocoon on the leaves of the vine. This operation is performed in a manner essentially characteristic: the worm cuts out a clean oval flap, leaving it hinged on one side, and, rolling this flap over, fastens it to the leaf, and thus forms for itself a cozy little house which it lines on the inside with silk. One of these cocoons is represented at Figure 76, *b*, and though the cut is sometimes less regular than shown in the figure, and I have had them spin up in a silk handkerchief without making any cut at all, it is undoubtedly the normal habit of the insect to make just such a cocoon as represented. In this cocoon, within two days, it changes to a chrysalis, such as is represented at Figure 76, *a*, of a honey-yellow color with a green shade on the abdomen; and in about ten days more the moth makes its escape, the chrysalis having first pushed itself almost entirely out of the cocoon. The moth is of a slaty-brown color with corky-yellow markings, and is represented enlarged at Plate 2, Figure 29, and of the natural size at Figure 30.

[Fig. 76.]



a *b*

Specimens of this moth were sent by Mr. Walsh to the English Lepidopterist, H. T. Stainton, who could not refer it to any known genus; but Dr. Packard, of Salem, Massachusetts, refers it to *Penthina* a genus very closely allied to *Carpocapsa*, to which our Apple Codling moth belongs. He has also kindly furnished me with advanced sheets of Part V of the "Guide to the Study of Insects," in which (p. 336) he describes and figures it under the name of *Penthina vitivorana*. The description is quite brief, however, and the figure not good, and I therefore subjoin a more detailed description of it in its different stages:

PENTHINA* VITIVORANA, Packard—*Larva.*—Average length 0.35. Largest on segments 10 and 11, tapering thence gradually to the head and suddenly to anus. Color either dark shiny olive-green, glaucous, or brownish. Head and cervical shield honey-yellow, the latter with a darker posterior margin. Piliferous spots scarcely distinguishable. Described from 10 specimens.

Crysalis—0.18—0.20 long. Of normal form. Quite variable in color. Usually of a light honey-yellow, with a green shade on the abdomen, and black eyes, but sometimes entirely dark-green, with light eyes. The chrysalis skin, after the moth has left, is always deep honey-yellow, with the green abdominal mark distinct.

Perfect insect—Average length 0.17; alar expanse 0.37. Head, thorax, palpi and basal half of antennæ fulvous Terminal half of antennæ darker. Legs fulvous, becoming darker on tarsi. Ground-color of fore wings pale slate-blue, with a slight metallic lustre, which becomes lighter and somewhat silvery interiorly and posteriorly. A dark rich-brown band, with a light, somewhat silvery annulation proceeds from the middle of the costa towards the inner margin, becoming paler interiorly; its basal margin being indistinct, but running almost straight across the wing, its outer margin well defined, curving to a rounded point which reaches to the middle of the outer third of the wing and thence running obliquely inwards, nearly to the middle of the inner margin. Beyond this middle band is a large, deep brown, somewhat oval spot, also lighter below than above, and with a pale annulation, which is broken on the outer side above, allowing the spot to extend to the margin of the wing. Above this large spot, at the apex, is a small perfectly round dark spot, with a bright annulation inclining to orange color. The space enclosed by the middle band, and these two spots just described, is brown above, with usually four lighter fulvous costal marks quite distinct, each mark divided at costa by a slight touch of brown. Another somewhat triangular brown spot, with a light annulation above, runs from the posterior angle up between the middle band and large oval spot. The blue space from the middle band to the base of wing is generally brownish near the base, with a brown line across the middle from costa to inner margin, and with two other costal brown marks. The fringes partake of the ground-color. Hind wings slate-brown, darkest near the margins; fringes same color. Body brownish with frequently a clear green tint. The male differs principally in its somewhat smaller size, and especially in the smaller size of the abdomen. Individuals vary greatly.

Described from 5 ♀ and 2 ♂ specimens, all well preserved and fresh.

REMEDIES.—This insect threatens to become a grievous pest unless checked by some unforseen means, as was the case with the Grape curculio. Luckily, there is at least one parasite which attacks it, in the shape of a yellowish, footless maggot, with a green tint and 14 segments. I obtained such maggots from two of the caterpillars, one having crawled out of its host before, and the other after he had spun up. Absence from home prevented my breeding this parasite, but it would doubtless have produced some 4-winged fly belonging to the *Chalcis* family (see Pl. 2, Figs. 6 and 9). According to Mr. Read, the first brood of caterpillars feed on the leaves, appearing in May (in Ohio) or as soon as the leaves are grown. The worms which appear in our grapes in July are, therefore, the second brood, and there is doubtless a third brood, for Mr. Rathvon received them in October, and I have taken the worm out of a grape as late as the 22d of September. The broods, in all probability, run into one another and the last passes the winter within the cocoon, either in the larva or pupa state. They should, therefore, be searched for early in the season on the leaves. The second brood of worms, or those which infest grapes, can easily be espied and destroyed in a healthy vineyard; but where a vineyard

*Heinemann and Lederer unite the genus *Penthina* wrth *Grapholitha,* under the latter name, and I believe Mr. C. T. Robinson, of New York, follows them in this respect.

is affected with what Prof. Turner, of Jacksonville, Illinois, designates as the "American Grape rot," the grape attacked by the Codling are not so easily distinguished, as they bear a close resemblance to the rotting ones. Care should be taken in gathering the infested grapes for the worm being very active wriggles away and easily escapes.

THE EIGHT-SPOTTED FORESTER, *Alypia octomaculata*, Fabr. Pl. 1, Figs. 18 and 19.

(Lepidoptera, Zygænidæ.)

At Plate 1, Figure 19, is represented a caterpillar which has been sent to me by several correspondents with the statement that it was found on their grape vines, and during the month of May, I found the same caterpillar on the vines of Mr. T. R. Skinner, of Cheltenham, and of Mr. Peabody, of Sulphur Springs. It grows to the length of 1¼ inches, and is transversely striped with bluish-white and black, about 4 white and 4 black lines on each segment, with two small black spots in the middle light band on the back. The head and a shield on the first segment are shiny gamboge-yellow, with black dots, and on the 11th segment there is an orange elevation, not shiny and with two black spots in it. From similar caterpillars, which were taken from grape vines in 1865 I bred in the spring of 1866 the moth figured at Plate 1, Figure 18, known as the Eight Spotted Forester (*Alypia octomaculata*, Fabr.) It is recognized at once by its conspicuous markings, being of a black color with orange shanks, each of the fore wings with two large light yellow spots and each of the hind wings with two white spots. The caterpillars leave the vines during the month of June, and descend into the earth where they form for themselves slight cocoons of earth in which they remain through the winter and from which the moth escapes the following April.

It is not probable that this caterpillar which may be called the Blue Caterpillar of the vine, will ever become exceedingly numerous, for it has not been known to become so in the past, and this hasty sketch of its history is given principally for the gratification of the intelligent grape-grower who takes pleasure in thoroughly understanding and knowing, in all their different guises, the creatures he has to deal with.

There are two other caterpillars very much resembling this, which also feed on the vine; but they produce very different looking moths, the one known as *Eudryas grata*, Fabr., and the other as *Eudryas unio*, Hübner. Dr. Fitch in his 3d Report §123 states that the larva of *E. grata* differs only from that of *A. octomaculata* in lacking a white spot on each side of every segment, and in being slightly humped at its hind end. The specimen from which my figure was made may prove to be *E. grata*, for it had no such white spots and *was* humped; but it differs essentially from the most excellent description of this last larva which A. S. Packard, Jr., has given in his "notes on the family Zygænidæ, pp. 27–29, and sufficiently resembles those from which I actually bred the 8-spotted Forester.

THE GRAPE-VINE PLUME, *Pterophorus periscelidactylus*, Fitch. Plate 2, Figs. 15 and 16.

(Lepidoptera, Alucitidæ.)

During the latter part of May and beginning of June, the leaves of the grape-vine may often be seen drawn together by silken threads and in the retreat thus made will be found a small hairy caterpillar which feeds on the tender leaves of the vine. This caterpillar grows to the length of about half an inch; the color of the body is very pale green and has four elevated white spots and two still smaller dots on every segment, from which spring stiff white hairs in all directions.

This caterpillar was quite common last summer in many sections of the State. It was first named by Dr. Fitch, who found it on the vine in the State of New York. A number which I brought home changed to chrysalids during the first days of June, and the moths were produced from them in about 8 days afterwards. The worm first spins a few threads of silk to the underside of a leaf, or other object, and the chrysalis attaches the lower part of the terminal segments to them, and hangs with the tail somewhat curved, at a slant of 40° from the object, as represented at Plate 2, Figure 16. This chrysalis measures 0.35—0.40 in length, is of a light-green color and of peculiar form. It is ridged, with remnants of the tubercles of the caterpillar. It is angular and cut off slantingly and bluntly at the head, but is characterised principally by two sharp and angulated projections from the middle of the back, and which are enlarged under the figure 16, in Plate 2.*

The moth (Pl. 2, Fig. 15) is of a tawny yellow color, the wings marked with white and with a darker shade. The caterpillars disappear very suddenly, for the chrysalis is so small and so nearly the color of the leaf, that it would be seldom noticed, even it were not so well hidden. There are probably two broods in the year, though I failed to find any trace of them after the first had disappeared.

All the moths of the family (ALUCITIDÆ) to which this belongs have very appopriately received the name of Plumes. In the genus *Pterophorus* the fore wings are divided into two and the hind

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*Dr. Fitch has given a most excellent and full description of this chrysalis in his 1st Report pp. 140–141.

wings into three lobes, and to show how very different insects may be in the larva state, both in habit and appearance, even when they belong to the same genus and greatly resemble each other in the perfect state, I have represented at Plate 2, Figure 13, another Plume, which I shall presently describe as the Thistle Plume.

REMEDIES.—Whenever they become numerous, as they did last summer, the only remedy is hand-picking.

THE TREE-CRICKET—*Œcanthus niveus*, Harris.

(Orthoptera, Achetidæ.)

This insect is represented in the annexed cuts, Figure 77 showing the male, and Figure 78 the female. The general color is a delicate greenish, semi-transparent white, though some specimens have a blackish shade. From the fact that it is known to devour plant-lice and likewise the eggs of some moths, I was formerly in doubts whether it should be considered friend or foe, but the experience of the past year settles the matter definitely, for it has proved very destructive to the vine. The female deposits her eggs in grape canes, raspberry and blackberry canes, in the twigs of the peach, White willow, and a variety of other trees. In depositing, she makes a straight, longitudinal, contiguous row of punctures, each puncture about the size of that which would be made by an ordinary pin. From each of these holes, a narrow, yellowish, elongate egg, runs slantingly across the pith. The twigs or canes thus punctured almost invariably die above the punctured part, and the injury thus caused to vines is sometimes considerable.

[Fig. 77.]

[Fig. 78.]

But by far the worst habit of the Tree-cricket is that of severing grapes from the bunches just as they are beginning to ripen, and it sometimes cuts off an entire bunch, or so thoroughly excoriates the stem that it fails to ripen its berries. I have seen the ground under some vines covered with grapes which had been thus severed, but should never have accused the Tree-cricket, had I not found it in the very act, and received specimens with accounts of this same habit, both from Mr. B. L. Kingsbury, of Alton, Illinois, and from J. H. Tice, of St. Louis. This cricket is aided in this destructive work by another species which has the same habit, namely the Jumping Tree-cricket (*Orocharis saltator*, Uhler.) This last insect is more robustly built than the former, and is at once distinguished by its uniform light-brown color, and I have good reason to believe that it deposits its eggs in the grape-vine in a row of punctures, each of which is about one-third of an inch apart, and each of which leads to from ten to twelve narrow eggs, about a tenth of an inch long, and deposited on either side of the puncture, length-wise in the pith.

Remedy.—The crickets themselves should be crushed whenever met with, while the vineyardist should make a business of searching in the winter time for all punctured twigs, and by burning them, prevent their increase in future.

THE RASPBERRY GEOMETER, *Aplodes rubivora*, N. Sp.—Pl. 2, Figure 25.

(Lepidoptera Geometridæ.)

The lovers of those most exquisite fruits, the Raspberry and the Blackberry are often greatly disgusted by the discovery of the fact that instead of the delicious berry which they expected to enjoy, they are munching the small caterpillar now under consideration. This caterpillar was quite numerous last summer on both the above named fruits at South Pass, Illinois. It has the peculiar faculty of thoroughly disguising itself with pieces of dried berry, seed, pollen, and other *debris* of the fruit, which it sticks to a series of prickles with which it is furnished. Add to this disguise the habit which it has of looping itself into a small ball, and it almost defies detection. It is most numerous during the months of June and July. Through the kindness of Mr. T. A. E. Holcomb, of South Pass, I was enabled to breed this insect to the perfect state. From two specimens of the larvæ which he sent me, I bred from one, July 9th, the little moth which is illustrated at Plate 2, Figure 25, the other being infested with a parasite which formed a tough cocoon, very much like that of a parasitic fly (*Campoplex fugitivus*, Say), which I have bred from milkweed feeding larvæ of *Euchætus egle*, Harris. This little moth is of a delicate light grass-green color, with two paler lines running across both wings as in the figure. It belongs to the genus *Aplodes*, and as I am informed by Dr. Packard, comes very near to *glaucaria* Guénée, and has not hitherto been described. In the proceedings of the Boston Society of Natural History (Vol. IX, pp. 300-2) Mr. Walsh has described an oak-feeding Geometer which closely resembles this, both in the larva and perfect states. He erected the new genus *Hipparchiscus*, for it and gave it the specific name *venustus*. It is a much larger insect, and differs in sundry respects from the species under consideration, though the moth is of the same color and somewhat similarly marked.

Aplodes rubivora, N. Sp. —*Larva*—Average length 0.80. Color light yellowish-gray, darker just behind each joint, and very minutely shagreened all over. On each segment a prominent pointed straight projection each side of dorsum, and several minor warts and prickles below. Two very slightly raised, longitudinal lighter lines along dorsum, between the prominent prickles. Ten legs.

Perfect insect—Alar expanse 0.50; length of body 0.25. Color verdigris-green, the scales being sparse so that the wings appear sub-hyaline. Fore-wings with two transverse lighter lines dividing the wing into three parts, proportionate in width as 3, 4, 2 counting from base, and parallel with posterior margin; also a faint line between these two, running to about ⅓ of wing from costa. Hind wings with two similar transverse lines, dividing the wing in like proportion, the outer line not parallel with margin, but wavy and produced posteriorly near its middle. Costa pale; fringes obsolete. Head, thorax and abdomen green above, but, together with antennæ and palpi, white beneath.

Described from one ♀ specimen.

THE GOOSEBERRY FRUIT-WORM, *Pempelia grossulariæ*, Packard.—Pl. 2, Fig. 17.

(Lepidoptera, Phycidæ).

On June 8th, I received from Mr. Geo. H. Cherry of Hematite, a number of diseased gooseberries, with an account of their prematurely turning red and rotting. The cause was a smooth thick glass-green worm which is more fully described below. Subsequently on the 12th of the same month, I received the same species of worm with a similar account of its work, from Mr. Stephen Blanchard, of Oregon; on the 16th from Jos. F. Bryant, of Bethany, with the statement that it was "feeding on and hollowing out" his currants, and on the 17th from Dr. W. A. Monroe of Bloomington with the statement that it was destroying his native gooseberries and Green gage plums. Mr. A. Fendler and F. R. Allen, both of Allenton, likewise informed me that it entirely ruined their currant crop, and I afterwards found the same insect on the currants and gooseberries wherever I went, and it doubtless occurs over the whole country, for as we shall presently see, it attacks the gooseberry both in the State of New York, Massachusetts, and in Canada.

[Fig. 79.]

a b

Dr. Fitch, in his 3d Report, §149, makes brief mention of it though he was not acquainted with the parent moth. He concludes his account in the following words: "I have sometimes seen bushes of the wild gooseberry with every berry withered and reduced to a mere dry hollow shell, with a cob-web like tube protuding from the orifice in one side. And the present summer a letter to the *County Gentleman*, from E. Graves Jr. of Ashfield, Mass., states that for three years past, his 'Houghton's seedling' gooseberries have been a total failure from this same worm, as I am assured by the account which he gives of it and the specimens accompanying his letter."

As soon as gooseberries and currants are well formed, this worm begins to make its presence known by causing the berries which it infests to prematurely turn red or dull whitish. After eating the inside of one berry, leaving a hole for the passage of the excrement, it enters another berry, making a passage way of silk, until it draws together a bunch of currants, or two or three gooseberries as the case may be. The berries thus attacked sometimes drop, but more generally the hollow shell mixed with cob-web-like silk shrivels up and hangs on to the bushes. During the latter part of June the worms descend from the shrub and spin for themselves brown cocoons (Fig. 79, *a*) in the leaves and rubbish on the ground. Here they change to brown chrysalids and remain in this state through the winter and come forth in the spring as moths. Thus there is but one brood of this insect each year, and yet by the middle of July there is never a worm to be found, and the chrysalis consequently remains quiescent alike through the hottest summer and the coldest winter weather. As the worms which I procured are still in the chrysalis state, I should have been unable to present the complete history of this pest, in this my first report, had it not been for the kindness of Mr. William Saunders of London, Canada, whom I met in Chicago, at the meeting of the "American Association for the Advancement of Science," and who very fortunately had with him specimens of the moth which he had bred from gooseberry-feeding worms, found in Canada, the description of which answered exactly to those of mine. But to make doubly sure that the insect which Mr. Saunders bred, is the same species as ours, I purposely forced one of my chrysalids. On the 25th of January, 1869, the markings of the wings showed through the chysalis skin, which was loose and brittle. These signs indicated that the forthcoming moth was in an advanced state of development, and on carefully taking away the chrysalis skin, it lay before me with nothing lacking to bring it to perfection but the inflating of the wings. Their markings were however perfect and distinct and agreed entirely with the Canadian specimen.

This moth is represented at Figure 79, *b* and still more faithfully at Plate 2, Figure 17, its general color being pale gray. It belongs to the genus *Pempelia*, and from advance sheets of Dr. Packard's "Guide" I learn that he has named it *P. grossulariæ*, and it may be known in English as the Gooseberry Pempelia.

Remedies.—Care should be taken to gather and destroy the worms while they are yet in the fruit, as they are afterwards found in the chrysalis state with great difficulty. If chickens are allowed to run amongst the bushes after the fruit has gone, they will materially assist in checking it by devouring such chrysalids as are within their reach.

Pempelia grossulariæ, Packard—*Larva*—Average length 0.65; thickest in the middle of body, tapering thence slightly each way. Color glass-green, partly translucent, shiny, and with a roseate hue on the upper surface. Head of a light gamboge-yellow, with tawny lips. Cervical shield not very prominent and of the same color. No other markings whatever. A few very fine white hairs, especially near the head and tail. 16 legs, the thoracic ones the same color as head, the others green.

Described from 10 specimens.

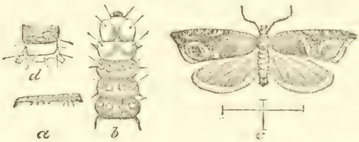
Chrysalis—Length 0.38. Of the normal form, and dull mahogany-brown color. The spiracles appearing like small tubercles and the extremity furnished with several stiff rufous curled bristles.

Perfect insect.—Length, including palpi, 0.40; alar expanse, 0.80. Color pale-gray. Front wings with a dark transverse diffuse band on the inner third, enclosing a zig-zag white line not reaching the costa. A dark discal spot, constricted in the middle, the upper and lower edges continued basally in the shape of two faint lines to the transverse band already mentioned, where they almost converge, the space enclosed by them being whiter than the rest of the wing, with a darker line along the middle. Beyond this discal spot, at about the outer fourth of the wing is another dark but less distinct diffuse transverse band, nearly parallel with posterior margin and with a white zig-zag line produced into an acute angle, basally, on the internal margin, the space between this band and the discal spot being also quite light. A row of marginal black dots, with the apex light. Fringes concolorous. Hind wings somewhat more dusky with darker margins and veins and lighter fringes. Head, thorax, abdomen, antennæ, palpi and legs all pale gray, being more silvery on the under than on the upper side.

One specimen from Wm. Saunders.

THE STRAWBERRY LEAF-ROLLER, *Anchylopera fragariæ*, Walsh and Riley—Pl. 2, Figs. 26 and 27.

[Fig. 80.]



The above figure represents an insect which devours the leaves of our strawberries. A more perfect picture of the moth is given enlarged at Plate 2, Figure 26, and of the natural size at Figure 27. It was first described in the January number of the *American Entomologist*, from which I take the following account of it.

For nearly two years, we have been acquainted with a little greenish leaf-roller, measuring about one-third of an inch, (Fig. 80, *a*), which in certain parts of North Illinois and Indiana, has been ruining the strawberry fields in a most wholesale manner; and which also occurs in Canada, judging from an account in the *Canada Farmer* of August 1, 1867. It crumples and folds the leaves, feeding on their pulpy substance, and causing them to appear dry and seared, and most usually lines the inside of the fold with silk. There are two broods of this leaf roller during the year, and the worms of the first brood, which appear during the month of June, change to the pupa state within the rolled-up leaf, and become minute reddish-brown moths (Fig. 80 *c*) during the fore part of July. After pairing in the usual manner, the females deposit their eggs on the plants, from which eggs in due time, hatches a second brood of worms. These last come to their growth towards the end of September, and changing to pupæ, pass the winter in that state.

We first heard of this leaf roller in the summer of 1866, when it did considerable damage at Valparaiso, Indiana, and we were informed by Mr. N. R. Strong, of that place, that in 1867 they continued their depredations with him, and destroyed 10 acres so completely as not to leave plants enough to set half an acre, and that in consequence of this little pest in conjunction with the White-grub, he has had to abandon strawberry culture.

When we met the *ad interim* committee of the Illinois State Horticultural Society at Lacon, in the beginning of July, 1868, we received from these gentlemen a quantity of infested strawberry leaves, from which in the course of the next two or three weeks we bred many of the moths. These specimens had been collected at Mr. Bubaugh's place, near Princeton, Illinois, where they were said to be very abundant, and to have completely destroyed one strawberry patch containing several acres.

Subsequently we received another lot of specimens from Mr. W. E. Lukens, of Sterling, Whiteside, county, Illinois, with the following remarks upon this very important subject:

"Where these insects are thick I would never think of raising strawberries. It is strange that I have not noticed any of their work upon this side the river; while on the south side for a mile up and down they are ruining the crops of berries. Removing the plants does not take with them the moth nor the eggs, so far as has been observed. A gentleman by the name of Kimball, at Prophetstown, had his crop a few years ago entirely destroyed by this insect, though it amounted in all to two or three acres. I hear of a great many men in other places having their crops burnt up with the sun, and have no doubt that it was this leaf-roller, and not the sun, that was the real author of the damage. As for myself, I have on this account entirely quit the business of growing strawberries."

The only modes of fighting this new and very destructive foe of the strawberry—which, however, seems to be confined to northerly regions—are, first, to plough up either in the spring or in the fall, such patches as are badly infested by it, by which means the pupæ will probably be buried and destroyed; and second, not to procure any plants from an infested region, so as to run the risk of introducing the plague upon your own farm.

We annex brief descriptions of this insect, both in the perfect and larval states. We are indebted to the distinguished English Microlepidopterist, H. T. Stainton, for the generic determination of the species, and for the further remark that "it is closely allied to the European *Anchylopera comptana* (Manual Vol. II, p. 225), which feeds on various Rosaceæ, such as *Poterium sanguisorba, Potentilla verna,* and *Dryas octopetala.*"

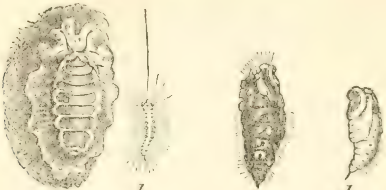
Anchylopera fragariæ, New species—Head and thorax reddish-brown. Palpi and legs paler. Antennæ dusky. Tarsal joints tipped with dusky. Front wings reddish-brown, streaked and spotted with black and white as in the figure. Hind wings and abdomen dusky. Alar expanse 0.40–0.45 inch. Described from nine specimens.

The Larva measures, when full grown, 0.35 of an inch. Largest on the first segment tapering thence very slightly to the last. Color varying from very light yellowish-brown to dark olive-green or brown. Body soft, somewhat translucent, without polish; the piliferous spots quite large, shining, always light in color, contrasting strongly in the dark specimens with the ground color. Hairs, especially lateral ones, quite stout and stiff. Spots arranged in the normal form, segments 2 and 3 having none, however, on their posterior half as have the rest (See Fig. 80, *b*) Head horizontal, of a shining fulvous color, with a more or less distinct dark eye-spot and tawny upper lip. Cervical shield of the same shiny appearance. Anal segment with two black spots (See Fig. 80, *d*) at posterior edge, being confluent and forming an entire black edge in some specimens. Legs, prolegs, and venter of the same color as the body above.

THE WHITE-MARKED TUSSOCK MOTH—*Orgyia leucostigma*, Sm. & Abbott.

(Lepidoptera, Arctiidæ.)

[Fig. 81.]



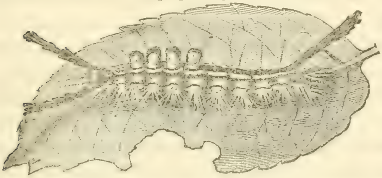
a *b* *c* *d*

During the winter little bunches of dead leaves are sometimes found to be quite numerous on our apple trees. They are generally fastened to the twigs, and upon examination are found to contain gray cocoons. The greater portion of these cocoons have an egg-mass glued to them, which is composed of numerous perfectly round, cream-colored eggs, of about 0.03 diameter, and partly covered with glistening white froth-like matter; while the other proportion of these cocoons have no such egg-mass.

About the middle of the month of May these eggs begin to hatch, and continue thus to hatch in different parts of the orchard for over a month. The young caterpillar which hatches from these eggs is represented at Figure 81, *b*. It at first measures 0.10 in length, and is of a dull, whitish-gray color with the underside paler or of a dirty white, and with the tufts on the back of a dark brown. In two days after hatching, orange spots commence to appear along the back, and especially on segments 2, 3, 8 and 9. On the seventh day after having remained stationary for about two days, fastened to some part of the tree with silk, it casts its skin for the first time, after which operation the hairs are more numerous, the dark portions more intensely black, the orange parts of a brighter orange and the two tufts near the head longer. As it approaches the time of the second moult, the underside becomes more glaucous, a yellow line begins to appear at the sides, and in some cases the orange marks become yellow, with the exception of a small, perfectly round spot on segments 9 and 10 which always remains orange; the neck or first segment, where it joins the head, also becomes orange or yellow. Six days from the time of the first moult the second moult takes place, the worm having become lighter colored each day. Immediately after the shedding of the second skin it measures 0.30; the collar is more intensely orange as well as the head, while four cream-colored tufts appear on the back of segments 4, 5, 6 and 7, and the two round spots on segments 9 and 10 are of a very bright scarlet-orange. As it grows and approaches the third moult, the orange collar becomes more conspicuous, the back becomes of a perfect velvety black; the cream-colored tufts become smaller, whiter, and the fourth frequently obsolete; a transverse row of four yellow warts becomes conspicuous on segments 2 and 3; a subdorsal yellowish line appears, starting from segment 8 and running and diminishing posteriorly; the upper sides become of a dark bluish-gray, while the yellow line along the lower sides becomes more distinct. Six days after the second moult the third moult takes place with but little change in the appearance of the caterpillar, further than that the different colors become still more bright and distinct and the different tufts still larger.

Up to this time all the individuals of a brood have been alike, and of a size, so that it was impossible to distinguish the sexes. Six days from the third moult, however, the males measure not quite $\frac{3}{4}$ of an inch, and begin to spin their cocoons; while the females undergo a fourth moult about this time, and in about six days more they also spin up, having acquired twice the size of the male when he spun up.

[Fig. 82.]



The annexed Figure 82 represents the full grown female caterpillar, it differing from the full grown male only in its larger size. At this stage of its existence the caterpillar is a most beautiful object, with its vermillion-red head and collar, its cream-colored brushes and its long black plumes.

When young these caterpillars make free use of a fine web which they spin, and by which they let themselves down when disturbed, and it is quite amusing to watch them ascend again whenever they have become sufficiently assured that there is no danger. They perform this feat with the thoracic legs, using those of each side alternately, the body and head being thrown from side to side in harmony, very much as a sailor climbs a rope "hand over hand."

It may puzzle some persons to divine how such a hairy and tufted caterpillar can possibly cast off its skin and yet retain these pretty appendages. After having remained stationary without food for about two days, the old skin becomes dry and somewhat loose. If at this time this old skin be carefully removed, it will be found that an entirely new set of these appendages has been forming underneath it; the two long plumes curled over the head, down by the feet and up again to near the scaly collar; the four white brushes folded close together inwardly crossing each other; the anal plume folded below the anus, and all the other hairs laid in thread-like bunches close to the body in a posterior direction. In due time the old skin splits on the back, near the head, and the caterpillar gradually works it off posteriorly. The moment they are exposed the appendages which had been compressed, as described, to the body, commence to straighten out, and in a few minutes the new dress is displayed in all its beauty and freshness. The long plumes at the head do not straighten out of their own accord, however, for the caterpillar by a curious curling of the body, while resting on a few of its abdominal prolegs, cunningly brushes them with its tail end, first on one side, then on the other. It furthermore presses them, for the same end, one after the other against any surface on which it is at the time walking, and having once thoroughly straightened out its toilet it rests a few minutes from its efforts and then commences to feed with surprising vigor, apparently determined to make up for its two day's fast.

The male cocoon is white or yellowish, and sufficiently thin to show the insect within it. It is formed of two layers, the outer one having the tufts and plumes which adorned the maker, scattered through it. The female cocoon is twice as large and more solid and dense.

Soon after completing his cocoon the male changes to a chrysalis, which is represented of the natural size at Figure 81, *d*. The female, in due time, changes to a very different chrysalis, which is also represented life-size at Figure 81, *c*. In about two weeks after spinning up, the moths begin to issue. In this state the sexes are still more dissimilar. The male produces a winged moth, which is represented at Figure 83, while the female is furnished with but the merest rudiments of wings, and is destined to simply crawl to the outside of her cocoon, where, after the male has met her, she deposits her eggs, gluing and protecting them with the white frothy matter already described, which, at this time, has every appearance of spittle. She is faithfully represented at Figure 81, *a*, and after depositing her eggs, the body greatly contracts and she soon dies.

Fig. 83.

Such is an outline of the natural history of this pretty, but destructive caterpillar. In our State there are two broods each year, the moths of the first brood appearing during the latter part of May and fore part ot June, and those of the second brood in September and October. The periods given for the transformations are average periods, and in further illustration of the difficulty in drawing rigid lines of time, in the development of insects, I will state that from a hundred larvæ which hatch out in a single day, some will have produced moths while others are yet feeding in the caterpillar state.

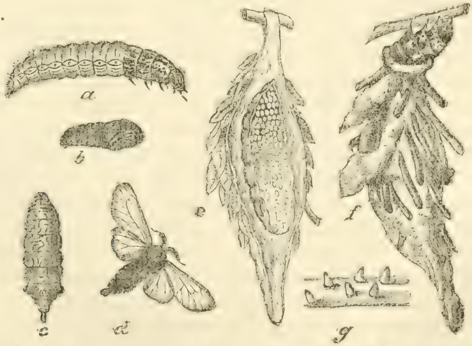
This insect seems to occur more or less over the whole country, and I have repeatedly received its egg-masses during the past two winters. It is, however, as we might expect from its nature, often confined like the Canker-worm, to particular orchards in a particular neighborhood. It feeds upon different kinds of trees, such as the elm, maple, horse-chestnut and oak, but it seems to prefer the apple, the plum, the rose and the pear.

REMEDIES.—Dr. Fitch has described two parasites, which attack this caterpillar, and I am acquainted with seven others, making in all nine distinct parasites, which prey upon this species. It was my intention to have described and figured some of these parasites, but the time in which this Report must be ready for the Public Printer forbids my doing so, the present year, and it suffices to say that in collecting the cocoons in the winter in order to destroy them, *none but those which have the egg-masses on them should be taken, as all the others, either contain the empty male chrysalis or else some friendly parasite!* From the fact that the female never travels beyond her cocoon, it becomes obvious that, since the insect can only travel in the caterpillar state, it would require over a century for it to spread even a hundred miles. Hence we may rightly conclude that it has been introduced to different parts of the country in the egg-state on young imported trees. How essential it is then to examine every tree in planting out a young orchard, and how easy it is with the proper precautions to forever keep an orchard free from its destructive work. As already stated, the young worms let themselves down upon slightly jarring the tree, and though after the third moult they lose this habit to a great extent, yet they may always be brought down by a good thorough shake, and where they have once invaded an orchard, this will be found the most feasible mode of killing them: though *prevention* by destroying the egg-masses in the winter when they are easily discerned, is infinitely the best and surest remedy against its attacks.

THE BAG-WORM, *alias* BASKET-WORM, *alias* DROP-WORM—*Thyridopteryx ephemeræformis*, Haworth.

(Lepidoptera, Psychidæ.)

[Fig. 84]



Our shade and ornamental trees are often defoliated by various insects, and I will give brief accounts of three which have attracted my attention during the past summer. Of these, the insect whose transformations are illustrated above, is by far the most common and injurious. It apparently flourishes better south of latitude 39° than north of that line. It occurs on Long Island, and in different localities in Pennsylvania, Ohio, Maryland, District of Columbia, the Carolines, Georgia, Alabama, Kentucky, South Illinois and in the southern half of our own State, and doubtless in some of the other States, though I have no records to judge by. In St. Louis county it is very plentiful. Year after year shade trees are planted along the streets and avenues of this city, and year after year a great proportion of them dwindle and die, until at last the opinion very generally prevails among landowners that it is of little use to try and grow them. Consequently they are not as generally planted as they should be, and St. Louis, with all her natural advantages, lacks to a great extent, those beautiful vistas and long rows of trees which so characterize and adorn some of our more Eastern cities.

Why is it that so many of these trees dwindle? No one seems to know! Can it be owing to the character of the soil, or of the climate? Most emphatically, no!—in these respects there is no more favored city on the continent, and for the proof we need only to visit Mr. Shaw's beautiful gardens, or Lafayette Park, or any of the nurseries around the city. What then, is the cause? Why, the very Bagworm which forms the subject of this article. It swarms all over the city proper, but decreases in numbers, as a general rule, as one approaches or gets beyond the limits, and is comparatively rare in the above mentioned places. The reason for this is obvious when we understand its history, for it can spread but gradually, and has naturally multiplied most in those places where it has longest existed—namely, in the older parts of the town.

The natural history of the insect is interesting, and may be thus briefly given:

Thoughout the winter the weather-beaten bags may be seen hanging from almost every kind of tree. Upon plucking them many will be found empty, but the greater proportion of them will, on being cut open, present the appearance given at Figure 84, *e*; they are in fact full of soft yellow eggs. Those which do not contain eggs are the male bags and his empty chrysalis skin is generally found protruding from the lower end. About the middle of next May these eggs will hatch into active little worms, which, from the first moment of their lives, commence to form for themselves little bags. They crawl on to a tender leaf, and, attached to their anterior feet with their tails hoisted in the air, they each spin around themselves a ring of silk, to which they soon fasten bits of leaf. They continue adding to the lower edge of the ring, pushing it up as it increases in width, till it reaches the tail and forms a sort of cone, as represented at Figure 84, *g*. As the worms grow, they continue to increase their bags from the bottom, until the latter become so large and heavy that the worms let them hang instead of holding them upright, as they did while they were young. By the end of July they have become full grown, when they present the appearance of Figure 84, *f*. The worm on being pulled out, appearing as at Figure 84, *a*. This full grown condition is not attained, however, without critical periods. At four different times during their growth these worms close up the mouths of their bags and retire for two days to cast their skins or moult, as is the nature of their kind, and they push their old skins through a passage which is always left open at the extremity of the bag, and which also allows the passage of the excrement.

During their growth they are very slow travelers and seldom leave the tree on which they were born, but when full grown they become quite restless, and it is at this time that they do all their traveling, dropping on to persons by their silken threads and crossing the sidewalks in all directions. A wise instinct urges them to do this, for did they remain on one tree, they would soon multiply beyond the power of that tree to sustain them, and would in consequence become extinct. When they have lost their migratory desires, they fasten their bags very securely by a strong band of silk to the twigs of the tree on which they happen to be. A strange instinct leads them to thus fasten their cocoons to the *twigs* only of the trees they inhabit, so that these cocoons will remain secure through the winter, and not to the leaf-stalk where they would be blown down with the leaf.* After thus fastening their bags, they line them with a good thickness of the same material, and resting awhile from their labors, at last cast their skins and become chrysalids. Hitherto the worms had all been alike, but now the sexes are distinguishable, the male chrysalis (Fig. 84, *b*) being but half the size of the female chryalis (shown inside of the bag at *c*). Three weeks afterwards a still greater change takes place, the sexes differentiating still more. The male chrysalis works himself down to the end of his bag and, hanging half-way out, the skin bursts and the moth (Fig. 84, *d*) with a black body and glassy wings escapes, and when his wings are dry, soars through the air to seek his mate.— She never leaves her case, but issues from her chrysalis in the shape of an abortive, footless and wingless affair (Fig. 84, *e*) and after copulating, works herself back into the chrysalis skin, fills its upper but posterior end with eggs and stops up the other end with what little there is left of her body when she gets through. These eggs which are quite soft and yellowish, pass the winter protected in the bags, and produce young worms again the following spring, which go through the same cycle of transformations thus hurriedly described.

This insect is essentially polyphagous, for it occurs alike on ever-

*I have noticed that the Ailanthus tree is almost entirely exempt from the attacks of this worm, but cannot yet tell whether this is because the leaves are repulsive to it, or whether, the leaves being compound, the worm's instinct fails it, in that it fastens its case to the mid-stalk, which falls and carries the case with it to the ground. I incline to the latter belief however, from the fact that the insect is such a general feeder, and that a few isolated cases are sometimes seen attached even to Ailanthus twigs, showing that they can feed and mature on this tree.

green and deciduous trees. I have found it on the elms, the common and the honey locusts, Lombardy poplar, catalpa, Norway spruce, arbor-vitæ, Osage orange, soft and silver maples, sycamore, apple, plum, cherry, quince, pear, linden, and above all on the red cedar, while Mr. Glover has also found it on the cotton plant in Georgia. It is also exceedingly hardy and ruddy, and the young worms will make their bags of almost any substance upon which they happen to rest when newly hatched. Thus they will construct them of leather, paper, straw, etc., etc., and it is quite amusing to watch their operations.

NATURAL REMEDIES.—The only parasite which has been hitherto known to attack this Bag-worm is one known as *Cryptus inquisitor*, Say, which Mr. Glover figures on Plate 11, Figure 5, of his yet unpublished plates of four-winged flies. Last September, through the kindness of Miss M. E. Murtfeldt of St. Louis, I discovered another parasite which lives in the body of the worm to the number of five or six at a time, and which after destroying their victim, spin for themselves tough white silken cocoons within the bag, as represented at Plate 2, Figure 10. The Ichneumon fly which issues from these cocoons has never been described, and as the sexes differ remarkably, I subjoin a full description of each. The female is represented at Plate 2, Figure 11, and the male at Figure 12, and it will be seen at once that while the wings of the former are clouded, those of the latter are perfectly clear. This fly belongs evidently to the genus *Hemiteles* though it differs from most species in having the areolet wanting.

HEMITELES (?) THYRIDOPTERYX, N. Sp.—♀ Length, 0.36; expanse 0.50. Ferruginous, opaque. Head transverse, rather broader than thorax, the front much depressed; face prominent centrally beneath antennæ, closely punctured, thinly clothed with pale pubescence; clypeus and cheeks shining; tips of mandibles black; antennæ, long, slender, filiform, ferruginous, blackish at tips; thorax rugose; scutellum prominent, with sharp lateral margins; metathorax prominent, quadrate, abrupt laterally and posteriorly, finely reticulated and pubescent, the upper posterior angles produced on each side into a long, divergent, flattened, subacute spine; disk with two longitudinal carinæ, from which diverges a central transverse carina; tegulæ piceous; wings hyaline, subiridescent; a narrow, dark fuliginous band crosses the anterior pair a little before the middle, and a broad band of same color between middle and apex, this band having a median transverse hyaline streak; areolet wanting, second recurrent nervure straight, slightly oblique; apex of posterior wing fuscous; legs long and slender, ferruginuous, more or less varied with fuscous; posterior coxae, tips of their femora, and their tibiæ and tarsi, fuscous; base of four posterior tibiæ more or less whitish, forming a rather broad annulus on posterior pair; abdomen petiolated, subconvex, densely and finely sculptured, blackish, basal segment tinged with reddish, the second and third segments distinctly margined at tip with whitish; apical segments smooth and shining, thinly pubescent; ovipositor half as long as abdomen, sheaths blackish.

♂.—Not at all like the ♀. Length 0.33, expanse 0.44. Long, slender, black, polished, without distinct punctures, thinly clothed with white pubescence; palpi white; antennæ long, slender; scape reddish; mesothorax gibbous, with two deeply impressed longitudinal lines; metathorax with well-defined elevated lines, forming several irregular areas; sides rugulose, apex without spines or tubercles; tegulæ white; wings whitish-hyaline, subiridescent, the nervures and stigma white, subhyaline, neuration as in ♀; legs long, slender, pale honey-yellow; coxæ, posterior trochanters, apex of their femora, and their tibiæ and tarsi, blackish; base of posterior tibiæ with a white annulus; abdomen long, slender, flattened, petiolated, smooth and polished, the apical margin of second segment being narrowly whitish.

Described from four ♀ and one ♂ specimens bred from the same cocoon.

ARTIFICIAL REMEDIES.—From the natural history of this Bag-worm it becomes obvious, that by plucking the cases in the winter time, and burning them, you can effectually rid your trees of them, and I advise all who desire healthy trees to do this before the buds begin to burst in the spring. Where this is not done the worms will continue to increase, and partly defoliating the tree each year, slowly, but surely, sap its life.

In conversation some time since with Mr. Edward Cook, who is superintending the improvements in Washington Park, St. Louis, I showed him that every one of the young trees that had been lately planted there had from six to a dozen of these Bag-worms hanging from their twigs. I explained to him that the trees would never thrive with these parasites, and that, prevention being easier than cure, he had better have them plucked off at once, while they were within reach. He informed me afterwards that he had gathered two barrels full from these trees, but there are many yet left, which should be removed before spring.

THE AILANTHUS WORM—Larva of *Œta compta*, Clem., Plate 2, Figs. 22 and 23.

(Lepidoptera, Tineidæ.)

The Ailanthus is highly prized in most of our cities as a shade tree, and though there certainly are other trees as quick growing, and as hardy, which might advantageously take its place, yet as it has an almost perfect immunity from the attacks of the Bag-worm and continues to be grown, it will be of interest to know what insect enemies it has. Fortunately it has very few, but every St. Louisan must have noticed last fall that nearly all the young Ailanthus trees around the city, and in the parks, looked black and seared as though they had been scorched by fire. Few probably divined the cause of this phenomenon, but it was the work of the worm which is the subject of this chapter.

This worm is slender and of a very dark olive-brown color, with white longitudinal lines. During the months of August and September it may be found of all sizes, living in communities of from five to thirty individuals within a slight silken web. Did they but feed on the leaves their injury to the tree would be slight, but they have the miserable habit of gnawing the leaf stalk in two, and of severing the leaf, and causing it to turn black; thus marring the looks of large trees and killing many seedlings outright. When the worm is full grown it suspends itself in the middle of the loose web and changes to a chrysalis about $\frac{1}{2}$ inch long and of a dull smoky-brown color. The chrysalis skin is so very fine, that as the future moth develops within, the colors of its wings show distinctly through it. The chrysalis state lasts on an average about two weeks, at the end of which time the moth bursts forth. In this state it is one of the neatest and most beautiful little moths that can well be imagined. At Plate 2, Figure 22, it is represented of the natural size, expanded, and at Figure 23 with the wings closed. The fore wings are of a bright metallic golden-orange, crossed transversely with bands of very pale chrome-yellow, marbled with black; while the underwings are smoky black, and almost transparent in the middle. The first moths begin to appear during the first days of September, and continue issuing from the crysalids till the last of October. From the fact that I could get none of them to deposit eggs, I infer that they pass the winter in the moth state—the more readily since I have had them escape from the crysalis even in November. They are very fond of flitting over and clinging to the flowers of the Golden rod and of the *Eupatorium serotinum.*

This insect probably occurs throughout the Southern States, for Mr. Glover has found it in Georgia. It is doubtless confined to the Ailanthus tree, though when pushed for food I found that the worms were not at all fastidious about devouring their brethren that were in the helpless chrysalis state. It was named *Pæciloptera compta* by the late Dr. Breckenridge Clemens, but as the genus *Pæciloptera* was pre-occupied in insects, Mr. A. Grote, of New York, proposed the generic term *Œta*, and we thus have a scientific name for our little moth—*Œta compta*—which the most prejudiced against the so-called "Crack-jaw-Latin" can hardly find objection to.

The easiest way of getting rid of the worms is to cut off the branch containing the nest and burn it.

ŒTA COMPTA, Clemens.—*Larva.*—Average length when full grown 0.95. Slender, the diameter being 0.09. General color very dark olive-brown An extremely fine pearly-white dorsal and subdorsal line, and a somewhat more distinct stigmatal line of the same color; all three of them formed by minute white specks and lines. Dorsum, dull olive-green. A longitudinal line somewhat darker and in many cases quite black, below the subdorsal line. Between this last and stigmatal line is a stripe of the same color as dorsum, but speckled with white. Immediately below stigmatal line, it is rusty-yellow, especially on the middle segments. Venter sometimes olive-green, sometimes lead-color, finely speckled with white, and with a translucent line visible along the middle. This larva is mainly characterized, however, by a number of minute white piliferous spots, in strong contrast with the dark body, each giving forth a stiff white hair at right angles from said body. These spots are thus arranged on each side of every segment: 2 about the middle on subdorsal line; 1 under the anterior of these, just below the longitudinal dark line; 2 on the stigmatal line, with the stigmata which is of the same color between them; 1 in the orange part posteriorly; 2 small ones just below the orange part, and 2 in the middle of venter on the legless segments. Head of a beautiful brown, perpendicular, marked with black and speckled with white, two large spots being especially noticeable on the upper front. Cervical shield velvety-black, irregularly speckled with white. Thoracic legs black; abdominals extremely small and of the same color as venter; anals somewhat larger and brown.

Described from numerous specimens. The white spots are usually larger near the head while the hairs springing from them lean towards the head. The head itself is sometimes entirely black, while the white longitudinal lines are occasionally almost obsolete.

The young worm is pale and void of markings.

Chrysalis.—Average length 0.53. Not polished, but with the markings of the larva still apparent through the thin skin. General color dull smoky-brown, with a distinct broad dorsal band of a light rust-brown color along the abdomen, and a perfectly round spot of the same color on the top of the thorax, this spot generally giving forth a narrow orange line posteriorly.

Perfect Insect.—Average length 0.55; alar expanse 1.08. Fore wings bright lustrous golden-orange, crossed transversely with irregular bands of sulphur-yellow spots on a black ground as in the figure; fringes dense, narrow and brown. Hind wings smoky black, sub-hyaline except near apex and along margins; veins dusky, fringes also. Under surface of front wings dusky brown with the colors of the upper surface partly visible; under surface of lower wings concolorous. Head black with sulphur-yellow tufts; eyes black; palpi alternately black and sulphur-yellow; antennæ filiform, slightly serrate, black with a white shade along the upper terminal third. Thorax black with a wavy sulphur-yellow collar, golden-orange shoulder-covers with a spot of the same color between them, and two sulphur-yellow spots below this last. Abdomen steel-blue above, with a large brimstone-yellow patch on each segment below. Under surface of thorax black with brimstone-yellow patches; legs black, the front pair with yellow *coxæ* and orange thighs, the other four with more or less yellow, especially on the thighs.

Described from numerous specimens. No particular sexual difference, except in the form of the body.

THE WALNUT TORTRIX, *Tortrix Rileyana*, Grote—Pl. 2, Figs. 3 and 4.

(Lepidoptera, Tortricidæ.)

During the month of May large bunches of the leaves of the Black Walnut and of the Hickory may be found drawn together by a silky web, and living within these bunches, a nest of caterpillars of a yellow color and marked as at Figure 85, *a*; *b* showing a side view of one of the segments. During the latter part of the month they change to little honey-yellow chrysalids, within the nest, and by the middle of June these last work their way through the leaves to the outside, by means of rows of minute teeth which they have on the back. Here they hang in great numbers by the tips of their abdomens, and in a short time the moths escape.

[Fig. 85.]

a *b*

This moth is represented at Plate 2, Figure 3, with the wings expanded, and at Figure 4 with wings closed. It is prettily marked, the fore wings being of an ochreous color with a golden tint, and darker spots, and the hind wings of a deep golden color. It was first described by Mr. Grote, of New York, in the Transactions of the American Entomological Society, Vol. II, p. 121. It was quite common in 186[illegible] along the Iron Mountain road, and seems to be peculiar to Missouri. It also seems to prefer the young Hickories and Walnuts to the older or larger trees, as I found few nests that were out of reach.

On the Snowberry* (*Symphoricarpus vulgaris*), similar nests may be found at the same time of year, containing caterpillars agreeing in description with those feeding on the Walnut and Hickory, except in being smaller. They go through their transformations in the same manner and produce moths similarly marked but uniformly

*They also occur on the Ironweed (*Vernonia fasciculata*), though I have not bred the moth from worms feeding on this plant.

paler in color, of smaller size and with less contrast between the upper and lower wings. We have here an excellent illustration of what Mr. Walsh has called Phytophagic variation,† for the Snowberry and Hickory feeding worms were evidently of but one species, and the difference in the moths was caused in my estimation by the difference in food. Mr. Grote, it is true, describes the small form as the male and the large form as the female, but the difference is not sexual, as the two sexes occur alike in both forms.

TORTRIX RILEYANA, Grote—*Larva*—Length, Hickory feeding, 0.60-0.80; Snowberry feeding, 0.40-0.50. Largest on segment 2, tapering thence gradually to anus. Ground color dull yellow. Covered with large, distinct, black, sealing-wax-like, slightly elevated spots, each giving rise to several fine bristles. These spots are thus arranged on each segment: 2 each side of dorsum the posterior ones widest apart; 1 at sides in the middle of the segment, containing the stigmata in its lower hind margin; 1 smaller and narrower just below this, on a somewhat elevated longitudinal ridge, and 1 round one below this ridge on the posterior part of the segment. Segments 2 and 3 have but one spot each side of dorsum. Two distinct wrinkles on all the segments, more on 2 and 3. Head, cervical shield and caudal plate black. Venter dirty yellow with black marks; legs ditto.

Chrysalis—Honey-yellow, robust in the middle, and with two transverse rows of minute teeth across the back of each segment.

Perfect Insect—From Hickory—Average expanse 1 inch, length of body, 0.35. Deep ochreous. Fore wings evenly washed with purplish, leaving the fringes and costal edge dark ochreous. The markings take the shape of dark velvety brown rounded maculations, generally of small size and faintly shaded with ochreous on the edges. Three of these subterminally at the base of the wing, subequal, situated interspaceally between the nervures. At a little within the middle of the costa are two fused maculations, the most prominent. Before and beyond these, some faint costal marks. At the extremity of the discal cell, above median nervure, is the first of a series of maculations, normally four in number but not constant, usually uneven in size. A subterminal series of spots is inaugurated on costa by a large, compound shaded maculation. Below this, over the median nervules, sweeps an outwardly rounded series of small approximate dots. Two dots on costa, within and at the apex, and a faint terminal series of minute streaks is shortly discontinued. Hind wings of a lustrous bright deep ochreous; pale along the costal margin and darker shaded along internal margin. Beneath, as are the hind wings above; both wings immaculate, fore wings the darker. Body and appendages concolorous, bright deep ochreous. Antennæ simple. Numerous bred specimens.

From Snowberry—var. symphoricarpi—Much paler, the fore wings not being as dark as the hind wings of the above. The upper surface of fore wings not washed with purplish but merely of a darker ochreous than the hind wing. The maculations entirely similar but ferruginous, paler and the slighter costal marks obsolete. Legs at base and under thoracic surface almost whitish Average expanse, 0.62; length of body, 0.30. Described from numerous specimens. Under surfaces exactly alike in both varieties.

THE SEED-CORN MAGGOT, *Anthomyia zeas*—N. Sp.—Pl. 2, Fig. 24.

(Diptera Muscidæ.)

DESTROYING THE SEED AFTER IT IS PLANTED.

About the 20th of last June I received the following letter from A. S. Fuller, of Ridgewood, New Jersey:

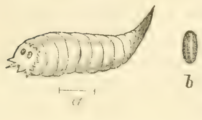
"DEAR SIR: I send you, by mail, a small box containing kernels of sprouted corn, upon which you will find small white worms. Some of the corn fields in this vicinity are being ruined by this pest. These worms attack the corn before it comes up. What are they?"

† See his paper in Proc. Phil. Ent. Soc., Vol. V, p. 194-216.

Subsequently I was informed that the seed-corn in other fields in Bergen county, New Jersey, was being destroyed in the same manner. The cause of this destruction is a footless maggot, measuring 0.25 to 0.30 of an inch in length, of a yellowish-white color, blunt at the posterior and tapering at the anterior end. It is a new foe to corn, and it is to be hoped that it is confined to the localities above mentioned. In order that it may at once be recognized, I give the following brief account of it:

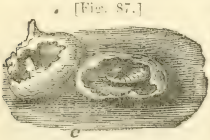
This maggot is shown, enlarged, at Figure 86 *a*, the hair line underneath giving the natural size. It greatly resembles the Onion maggots, which are known to attack the onion in this country, and its work on corn is similar to that of this last named maggot on the onion; for it excoriates and gnaws into the seed-corn, as shown at Figure 87, and finally causes such seed to rot.

[Fig. 86.]



After having become full fed, these maggots usually leave the kernels for the surrounding earth, where they contract into smooth, hard, light-brown pupæ, of the size and form of Figure 86 *b*, and in about a week afterwards the perfect fly pushes open a little cap at the anterior end, and issues forth to the light of day. In this state it is a two-winged fly belonging to the order Diptera, and quite inconspicuous in its markings and appearance. Though I bred but two females, and this sex fails to exhibit some of the most important generic characters, yet there is nothing in the females of this species to distinguish it from the genus *Anthomyia* proper, of Meigen, as restricted by Macquart, and this Corn maggot, therefore, belongs to the same genus as the imported Onion fly (*Anthomyia ceparum*, Meigen). Upon submitting a specimen, for inspection, to Dr. Wm. Le Baron, of Geneva, Illinois, who has paid especial attention to our two-winged flies, he informed me that it is distinct from any hitherto described North American species, and I have, therefore, called it the Corn Anthomyia (*Anthomyia zeas*).

[Fig. 87.]



ANTHOMYIA ZEAS ♀, N. SP. (Pl. 2, Fig. 24). Length 0.20; alar expanse 0.38. Antennæ black; style mircoscopically pubescent; front, fulvous, with a distinct, rather narrow, brownish, cinereous margin; face and orbits brownish-white; palpi and proboscis black; ocellar area somewhat heart-shaped; thorax and abdomen pale yellow-brownish cinerous, with minute black points at the insertion of the bristles; thorax with an indistinct middle stripe of brown; legs black, tinted with cinereous; poisers pale orchre-yellow; scales small, the upper valve larger than the lower.

It is difficult to suggest a remedy for this pest, as its presence is not observed till the mischief is done. Hot water has been found effectual in killing the Onion maggot, without injuring the onions, and would doubtless prove as effectual for this Corn maggot, where a few hills of some choice variety are attacked, which it is very desirable to save. But its application in a large field, even if one knew where to apply it, would be impracticable, and I can only suggest soaking the seed, before planting, in gas-tar or copperas, and hope that the experiment will be tried next spring by those of our Eastern friends who have suffered from this maggot.

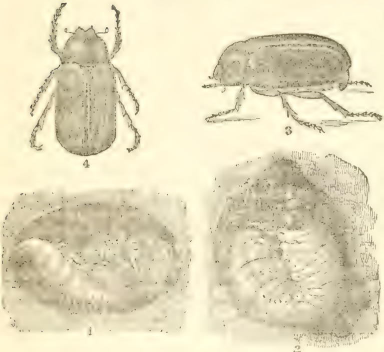
The larvæ of the genus *Anthomyia* live, for the most part, on vegetable matter, and seem to prefer it in a state of decay. Some, however, breed in excrement. Besides this corn species and the onion maggot already spoken of, there is one in this country that attacks radishes, and another that attacks the stem of cabbages. Specimens of this last species have been sent to me by Professor A. N. Prentiss, of Michigan Agricultural College, with the statement that they were proving very injurious to this esculent, around Lansing, in that State, and the flies produced from them seem to be identical with the species that attacks the cabbage in Europe (*Anthomyia brassicæ*, Bouché).

THE WHITE GRUB.

Larva of the May-beetle, *Lachnosterna quercina*, Knoch.

(Coleoptera, Melolonthidæ.)

[Fig. 88.]



The "White Grub is one of the very worst and insidious of the farmer's foes. To give its metamorphoses at a glance, and to obviate the necessity of verbal descriptions of so common an insect, I have prepared the annexed figure (88) which illustrates the full grown larva (2), the pupa (1), and side and back views of the beetle (3 & 4).

The following letter from Mr. Jno. P. McCartney, of Cameron, is a sample of numerous accounts of its depredations which I have received during the year.

"CAMERON, MISSOURI, Sept. 21, 1868.

"MR. C. V. RILEY, *Dear Sir:* The White grub worms have done us in this part of the State a great deal of damage. Will you please give us a history of the insect's habits. The grubs are now full grown, fine fat fellows. Two years since (1866), during the last of May, the beetles were very plenty. After sundown they came in great number and swarmed around the tops of the trees on the lawn, making a noise like the coming up of a storm of wind and rain. Last year (1867), the grubs did but little damage. What we want to know is, when will they leave the ground again as beetles? If they spend another summer in the ground it will be of but little use to try and raise a crop on the land that is now full of them. They have ruined all the meadow in this vicinity."

It is characteristic of the beetle to appear in vast swarms during the month of May—earlier or later, according to season or latitude. The beetle is quite voracious, and often greatly injures both fruit and ornamental trees. I have known the Lombardy poplar to die, in consequence of the utter denudation they caused; while last June certain groves of both Pin and Post oaks on the farm of Mr. Flagg, of Alton, Illinois, were so thoroughly and suddenly denuded by them, that Mr Flagg could not at first divine the cause. Their existence in the beetle state is however short, and as they are confined to the foliage, their injuries are exceedingly small compared with those which their larvæ inflict upon us. Our meadows, strawberry beds, corn, vegetables, and even young nursery stock, are all subject to the attacks of these White grubs, and often ruined by them. Soon after pairing, the female beetle creeps into the earth, especially wherever the soil is loose and rough, and after depositing her eggs, to the number of forty or fifty—dies. These hatch in the course of a month, and, the grubs growing slowly, do not attain full size till the early spring of the third year, when they construct an ovoid chamber, lined with a gelatinous fluid; change into pupæ, and soon afterwards into beetles. These last are at first white, and all the parts soft as in the pupa, and they frequently remain in the earth for weeks at a time till thoroughly hardened, and then, on some favorable night in May, they rise in swarms and fill the air.

This, is their history, though it is very probable, as with the European Cock-chafer (a closely allied species), that, under favorable conditions, some of the grubs become pupæ, and even beetles, the fall subsequent to their second spring; but growing torpid on approach of winter, remain in this state in the earth, and do not quit it any sooner than those transformed in the spring. On this hypothesis, their being occasionally turned up in the fresh beetle state at fall plowing, becomes intelligible.

Remedies.—As natural checks and destroyers of this grub, may be mentioned the badger, weasel, skunk, marten, the crow, and the different hawks, but especially the Ground beetles among insects, some of which have been figured on page 115 Hogs are fond of them, and a gang may be turned into an infested meadow, which is to be cultivated the next year, with good advantage. The grub sometimes so thoroughly destroys the roots of meadow grass that the sward is entirely severed; in such cases a heavy rolling would doubtless kill great numbers of them Applications of ashes and salt have been recommended, but I think they are of doubtful utility, unless sufficiently applied to saturate the ground to the depth of more than a foot. A field or meadow is badly injured during a certain year by the full grown grubs. The following spring the owner, ignorant of the insect's history, applies some substance to the land as a remedy, and finding no grubs during the summer following, will naturally conclude his application was effectual, when in reality the insects left of their own accord in the beetle state.

During their periodical visits as beetles, they should be shaken from the trees, gathered up, scalded and fed to hogs. As an illustration of what may be done in the way of hand-picking, I will state that under the efforts of M. Jules Reiset, the incredible amount of 100,000 kilogrammes, or about eighty millions of similar White grubs were collected and destroyed in a portion of the Seine-Inferieure of France, during the autumn of 1866.

The beetles make their appearance in different localities with great regularity every three years, and in a case like that communicated by Mr. McCartney, I should advise him to plant freely next spring without fear of their ravages; for he may rest confident that they will issue as beetles next spring and not be very troublesome again, as grubs, till the summer of 1871. At Unionville, according to Mr. A. L. Winchell, the beetles appeared "in millions" last spring, and I hope soon to be able to give the years in which they will appear in the different localities throughout the State. The White Grub is subject to the attack of a curious fungus, which the following item from the Sedalia, Pettis county, *Press* very well describes:

"W. B. Porter, of this county, has left at our office a specimen of the White Grub, so formidable as a corn, potato, and grass destroyer. There are two sprouts of green, vegetable growth, growing out of the head of the *grub*, one on either side, of nearly half an inch in length, resembling a hog's *tusk* in shape. Mr. Porter informs us that the one presented is by no means an isolated example, but that myriads of them can be found which present the same anomalous combination of animal and vegetable life. Who will explain this aberration from the well settled laws of organic life?"

In the second volume of the late *Practical Entomologist*, page 16, an account was given of the same fungus, great numbers of the grubs on Mr. Paulding's place at Tipton, Iowa, being affected with it. Dr. Kirtland, of Ohio, also evidently refers to the same fungus as being well known to science in the *Prairie Farmer* for 1865, Vol. XVI, p. 71. At Figure 89, I represent one of the grubs as it appears when attacked by this fungus, drawn from specimens received from Mr. Porter. The sprouts are almost invariably two in number and proceed from the corners of the mouth, but in one specimen which I have, there is but one near the mouth, the other protruding from the middle of the back.

[Fig. 89.]

In Virginia the grub seems to be attacked by another fungus, as the following letter of Mr. Sam. H. Y. Early, which was communicated to Mr. Walsh by the well known Entomologist, Wm. H. Edwards, abundantly shows:

"There is a white mushroom known in the region in which I was raised, as poisonous and fatal to the hogs that feed on it. I believe it is common in all localities in which I have been. In the spring of 1842 I observed in what is called a 'new ground' in Virginia a great quantity of these mushroom, and in reply to some remark I made about them, some of my father's negroes. who were then making hills with hoes for planting tobacco, inquired of me if I knew what produced these mushrooms. On my replying in the negative, I was informed that they grew from the White grub worm. I think there were some twelve or fifteen negroes present, all of whom curcurred in the statement, and said it was no new thing to them. They had no difficulty in establishing the truth of what they stated, because they dug them up in all their stages of germination and growth before my own eyes. In a very short time they had furnished me with a large number of the worms in their original shape, features and size, and as distiuct to the eye as if they had been alive, but having the consistency, color and smell of a mushroom; and I actually broke them up, just as a mushroom breaks in one's hands, snapping them crosswise and sqarely off. Many others I found to be enlarged before germinating, and many just germinating, but with the shape of the worm preserved. And in some I noticed that the features of the worm were preserved in the root, even after the mushroom had grown up through the earth and attained some size. I gathered a good many specimens in their various stages into my handkerchief, and carried them to my father's house, where they lay on the mantel for some time. They seemed, however, to be no novelty to many to whom I exhibited them. In fact they were familiar to almost all who had opportunities of investigation, and to whom I mentioned them at the time."

Whether there is any relation between these two fungoid growths further investigation will alone tell; but when we shall have become better acquainted with them we may possibly be able, by sowing the spores of either kind to effectually kill the White Grubs in our fields.

THE AMERICAN MEROMYZA—*Meromyza Americana*, Fitch.—Pl. 2, Fig. 28.

(Diptera Muscidæ.)

ATTACKING WHEAT.

About the middle of the month of June last, in all the wheat fields which I examined between Bluffton on the Missouri river and St. Louis, I noticed that a great many of the ears had prematurely ripened, had turned yellow and were stunted and shorter than the rest, and upon examination the kernels proved to be withered and shrunken.

In most fields about one per cent of the ears were thus affected, but in two fields near Hermann, from three to four per cent were injured in this manner. This appearance was variously attributed to Hessian fly, Midge, etc., etc., no one seeming to know the true cause. Upon examination I found that the last or ear-bearing joint could invariably be pulled out of its sheath with but a slight effort, and that it was perfectly yellow and dry, while the lower end bore an irregular and gnawed appearance. Upon splitting open the first joint of the stalk, a space of about a quarter of an inch was found to be completely corroded, so to speak, and filled with excrementitious matter, as shown at Figure 90, *a*. In this space would generally be found a pale watery-green maggot of the form of Figure 90, *b*, attenuated at one end and blunt at the other. I took a number of infested stalks home, and many of the maggots changed to green pupæ of the form and appearance of Figure 90, *c*. Before changing to pupa the maggot would sometimes crawl away from the joint and get nearer the head, between the stalk and the sheath. The pupa state lasted from 12 to 14 days, and the first flies emerged during the first week in July.

[Fig. 90.]

This fly is represented, magnified, at Plate 2, Figure 28, and belongs to the genus *Meromyza* in the family Muscidæ of the order Diptera. It appears to be the very same species which Dr. Fitch found flying about wheat fields in New York State, and which he described and named as the American Meromyza (*Meromyza Americana*), on page 299 of his 1st and 2d Reports.* He did not ascertain the habits of the larva, however, and they have ever since remained unknown. The fly measures, on an average, 0.17 to the tip of the abdomen, and expands about 0.28. It is of a pale yellowish-green, the head being more inclined to straw color. The eyes are black and there is a round black spot between them on the top of the head. There are three broad black stripes, with a bluish-gray cast, on the thorax, the middle one straight and extending anteriorly to the pedicel of the neck, the outer ones slightly rounded outwardly, not extending so far anteriorly, but extending around the scutel and joining the middle one posteriorly. The abdomen also has, above, three broad blackish stripes, which are confluent posteriorly and interrupted at each of the sutures. Wings prismatic, hyaline and greenish anteriorly, their veins and the tips of the feet being dusky.

In Europe the larvæ of the closely allied genera *Chlorops* and *Oscinis* have long been known to attack some part or other of the stalks of wheat, rye, barley and other small grains. Several species are figured and described by the English Entomologist Curtis in his

* My specimens are all somewhat smaller than Dr. Fitch's according to his description, and have black eyes instead of "bright green;" but upon submitting specimens to Baron R. Osten Sacken who makes a specialty of *Diptera* he referred it to the same species.

"Farm Insects," and one of them—the *Oscinis vastator*—though a very different fly, seems to have almost precisely the same habit as our insect. It is quite probable, also, that in this country as in Europe, there are two broods during the year, the second brood of larvæ attacking grain sown in the fall, but further investigation alone will decide these points.

. REMEDIES.—Much can be done in an artificial way by cutting off and destroying all the infested stalks, which may readily be recognized by the signs already described; but even if this plan should faithfully be carried out, it is doubtful whether it would pay in a country where labor is so scarce and demands such high wages as in ours. We therefore have to fall back on the only practical means within our reach, viz: that of varying the culture by alternate courses, and this style of cultivation will have to be more generally adopted, should this pigmy foe sufficiently increase as to greatly diminish the yield of the "staff of life." There is every reason to believe, however, that Nature has her own means of keeping these flies within due bounds, for they are known to be preyed upon by parasitic Ichneumon flies in Europe, and I noticed many flies of this last description, of polished hues and active movements, deftly darting through, and resting upon the wheat plants of the fields infested with the *Meromyza*.

THE SHEEP BOT-FLY, OR HEAD MAGGOT.—*Œstrus ovis*, Linn.

(Diptera, Œstridæ.)

(Fig. 91.)

For the benefit of sheep raisers I give the following brief account of the insect which causes "Grub in the head." The annexed illustration (Fig. 91) represents it in all its stages. 1 shows the Gadfly, life size, with wings closed; 2 the same with wings expanded; 3, the pupa from which the fly has escaped; 4 the full grown larva, dorsal view; 5 the same, ventral view; 6 the same when younger.

This insect is the dread of sheep in the Old as well as the New World, and was made mention of by the Greek physician, Alexander Trallien, as far back as the year 560.

The flies make their appearance in June and July, and deposit living maggots in the nostrils of the sheep. As soon as they are deposited they ascend the nostrils, causing great irritation on their way, until they reach the frontal sinuses; there they attach themselves by the little hooks or tentacula placed each side of the head, to the membranes which line the cavities, feeding on the mucus which is always to be found in them. Until they attain their growth they are of a creamy white color, with two brown spots placed side by side on the posterior segment. These spots, (6, *c*) are spiracles or stigmata, through which the worm breathes. The segment with these two spiracles, is retractile, and can be drawn in and hidden at the worms pleasure. When full grown, the grub becomes darker, particularly towards the tail, the white of the first two or three segments becoming dirty white on the 4th or 5th, and growing darker on each successive segment until the last, which is of a very deep brown. It has two small parallel hooks or tentacula at the head (*a*), and above these, two very small tubercles, not very easily shown in the engraving. It also has a small brown elevated round spot on each segment along the sides, which might at first be taken for spiracles but which are not, and also two small corneous appendages (5, *b*) on each side of the anus. The ventral region has a band of small elevated dots running the breadth of each segment in their middle, which, under the magnifier appear to be minute brown spines, all pointing posteriorly. (See Fig. 91, 5). These aid the worm in its movements.

When ready to contract into a pupa, it descends down the nostrils of the sheep and falls to the ground, where it quickly buries itself and in about 48 hours, contracts to half its former size, and becomes smooth and hard and of a black color, tapering as in the larva towards the head. It remains in this state from 40 to 50 days, or more, according to the weather, when the fly pushes open a little round cap-piece at the head and thus arrives at maturity.

In this stage it looks something like an overgrown house-fly. The ground color of the upper part of the head and thorax is dull-yellow, but they are so covered with little round elevated black spots and atoms (scarcely distinguishable without the aid of a magnifier) that they have a brown appearance. The abdomen consists of 5 rings, is velvety and variegated with dark brown and straw color. On the under side it is of the same color, but not variegated in the same way, there being a dark spot in the middle of each ring. The feet are brown. The under side of the head is puffed out, and white. The antenæ are extremely small and spring from two lobes which are sunk into a cavity at the anterior and under part of the head. The eyes are purplish brown, and three small eyelets are distinctly visible on the top of the head. It has no mouth and cannot therefore take any nourishment. The wings are transparent and extend beyond the body, and the winglets, which are quite large and white, cover entirely the poisers. Its only instinct seems to be the continuation of its kind. It is quite lazy, and except when attempting to deposit its young, its wings are seldom used.

It has lately become the fashion with many members of the Agricultural press, to ridicule the idea that sheep die at all from grub in the head, and many even deny that the grub is capable of any injury to the sheep whatever. From the fact that this grub may be found in the head of almost every sheep that dies, in the Western States at least, it is undoubtedly true that many other diseases are cloaked by the popular verdict of "grub in the head." It is none the less true, however, that those Agricultural editors, who pretend to instruct, simply show their lack of practical knowledge, in butting against that which must be the firm conviction of every flock master, viz: that sheep do die *of* grub in the head, Messrs. Youatt and Clark notwithstanding.

Mr. Youatt declares: "It is incompatible with that wisdom and goodness that are more and more evident in proportions as the phenomena of nature are closely examined, that the destined residence of the *Œstrus ovis* should be productive of continued inconvenience or disease." I agree most decidedly with Mr. Randall, that "this is as far fetched as a conclusion, as the reasoning on which it is founded."

If grub in the head is not productive of inconvenience or disease, as the disciples of Youatt have it, whence the suffering condition, the loss of appetite, the slow, weak gait, the frequent coughing, the slimy and purulent matter, sometimes so profusely secreted as at times to almost prevent the animal breathing? Whence the tossing and lowering of the head, and the fits of frenzy, to which so naturally quiet and gentle an animal as the sheep is subject? All these symptoms result from grub in the head, and the animal frequently gets too weak to rise, and finally dies. These effects of the grub were well recognized and understood by such old writers and close observers as Reaumur and Kollar; while Mr. Dan'l Kelly, of Wheaton, Illinois; Towne Bros., of Geneva, Illinois; M. L. Cockrill, of Tennessee, and other well known flock-masters with whom I have either conversed or corresponded, are unanimous in ascribing these symptoms to the true cause; and the late S. P. Boardman, of Lincoln, Illinois, coincided with them in this respect. For my part, I would as soon believe that those parasites were beneficial, which are so injurious to man, either internally or externally, or those which prey upon our caterpillars and other insects, and invariably destroy them; for although, when there are but few grubs in the head, the injury they inflict is not perceptible, *they can never be beneficial*, and when numerous enough will undoubtedly cause death. They cannot live in the head of the sheep without causing great irritation by the spines with which the ventral region is covered and the hooks with which they cling to such a sensitive membrane as that which lines the sinuses. Moreover, when numerous enough to absorb more mucous than the sheep secretes, the grubs will feed on the membrane itself, and (according to the evidence of some practical sheep men) will even enter to the brain through the natural perforation of the ethmoid bone, through which pass the olfactory nerves; in either of which cases, they must cause the most excruciating pain. The natural fear also, which sheep have of the fly, and the pains they take to prevent its access to the nose, is of itself proof enough that it is obnoxious to them. The rabbit is subject to the attack of a very large gad fly (the *Cuterebra cuniculi* of Clark). I saw a half grown rabbit the past summer with an enormous swelling each side of its neck. On examination these swellings were found to be caused by the grubs of this fly, and the rabbit was so weakened and emaciated that it could scarcely move. No one could witness such a sight without being convinced that the parasite was injurious.

In the *Prairie Farmer* of October 14, 1865, the fact was published that the Sheep Bot-fly deposits *living* maggots in the nostrils of the sheep. It was published on the authority of Mr. Kelly, and both he and myself then believed it to be the first published account of the viviparous nature of this fly. But the following extract from a letter from the late lamented Samuel P. Boardman, of Lincoln, Illinois, shows that the same discovery has been made by three independent observers in this country. Mr. Boardman wrote as follows:

"All the authors, both European (at least all *English*) and American, from Youatt to Randall, will persist in saying that the fly deposits *an egg*, which hatches out, and crawls up the nostrils of the sheep, etc., etc. Now three independent and perfectly original discoverers have in our own country within twenty five years past, disproved the book account of the grub's transformations.

"John Brown—'Old Osawattomie John Brown,'—published an account in an Agricultural paper (I forget what one) about twenty years since, of his seeing, 'with his own eyes,' the fly drop the *perfectly formed and living grub* in the nostrils of sheep. Some seven years since, 'Old Dan Kelly,' of Du Page county, Illinois, made the same discovery and supposed that he was the only man who had ever done it. At the time he made known his discovery, at a meeting of the Illinois State W. G. Association held in Chicago, I thought also, that he was the first man to ever notice the like. Two or three years afterwards I saw the account of John Brown's discovery, in the *Ohio Farmer*, copied from an old paper dated about seventeen years previously. When Kelly and I were at the meeting of the National W. G. Association, I went with him to the *Ohio Farmer* office, and I found in the file, Old John Brown's account. Mr. Kelly took a copy of the *Farmer* containing it, home with him. That makes *two* perfectly original and independent discoveries of the fact alleged. Now then, within a year past (I think) I have seen a letter from Mark Cockrill, of Tennessee, (who, before the war, was one of the oldest, largest and richest wool growers in the South, as well as one of the richest men in the South), in which he speaks of having made the same discovery years ago, and in which he speaks of it as if he thought he was the only, and original discoverer. Here are three men widely separated, who, we must acknowledge, are all capable and honest observers, and yet, Randall, (or at least his publisher) continues to put forth in every new edition of the '*Practical Shepherd*,' the same old exploded (or should be) notion of the fly depositing *an egg*. I presume it is altogether likely that all modern English writers on sheep keep up the same thing—by copying from Youatt."

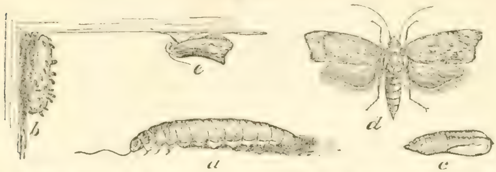
On one occasion in 1866, I myself obtained living maggots from one fly and Mr. Cockrill has since obtained over 300 living, moving worms from one that was caught while she was after the sheep. Many flesh-flies, if they cannot find suitable meat or carrion on which to lay their eggs, retain these egg so long in their bodies that they hatch there, into living larvæ; and it is not impossible that the above observations were made with flies that had been so circumstanced, but I think it highly improbable, and strongly incline to believe that it is the normal nature of this fly to produce living larvæ. I incline to this belief the more strongly, from the fact that it would be difficult to attach an egg to the slimy nostrils of a sheep.

To prevent it from depositing its young, different means are resorted to. Mr. Randall says that "some farmers turn up the soil in portions of their pastures, so that the sheep may thrust their noses into the soft ground, on approach of the fly, while others smear their noses with tar, or cause them to do so themselves." But as the fly is very persevering, and generally attains her object, the means to be depended on the most, is the dislodging of the larva, or "grub," and so far lime has been thought to be the most effectual, and should be given them, that they may by sniffing it, cause sneezing, and in many cases dislodge the grub. Some sheep keepers even shut their sheep up for several nights, in a tight barn, when first taken up in the fall, believing that the close and heated atmosphere induces the grub to descend, and is therefore more readily dislodged, and that the injury accruing from such foul air, is trifling, compared with the benefit received by dislodging the grubs. Other sheep breeders are in the habit of fixing salt logs in their pastures, of sufficient length to enable all the sheep to get at them. Into these logs, at distances of five or six inches, holes are bored with a two-inch auger, and during fly season a little salt is kept in these holes, while every two or three days tar is smeared around them with a brush. The sheep in obtaining the salt, tar their noses, and the odor of the tar keeps the fly away. In severe cases where the grubs are already in the head, they may be dislodged in a measure, by a feather dipped in turpentine, which should be run up the nose and gently turned.

INSECT ENEMIES OF THE HONEY-BEE.

THE BEE-MOTH OR WAX-WORM,—*Gallerea cercana,* Fabr.

[Fig. 92.]



Large hawk-moths sometimes enter a beehive for what honey they can get, and even mice have been known to enter a hive; while several parasites live upon the bees themselves. In our own State as I shall presently show there is a large two-winged fly which seizes the bee while on the wing and kills it. But by far the worst enemy the bee-keeper has to contend with, is the Bee-moth (*Galleria cereana*, Fabr). This insect is so well known to bee men generally, that it scarcely needs a description. It is well illustrated above (Fig. 92) in all its stages, *a* showing the full grown worm, *b* the cocoon which it spins, *c* the chrysalis to which it changes, *d* the female with wings expanded, and *e* the male moth viewed from the side with the wings closed. It suffices to to say, that the color of the moth is dusky gray, the fore wings which are scalloped at the end, being more or less sprinkled and dotted with purple-brown. The female is generally a good deal larger than the male, though there is not so much difference between the sexes as some writers have supposed. The worms which produce these moths are of an ash-gray color above, and yellowish-white beneath.

The Rev. L. L. Longstroth, in his excellent work on the Honey-bee, which every bee-keeper should possess, has given such a complete account of the Bee-moth, that it is only necessary for me to mention a few of the most important facts with regard to it, my object being principally to show that there can be no such thing as a *moth-proof hive*; that wire-gauze contrivances are of no avail, and that the man who pretends to sell a moth-proof *hive*, may usually be set down as a know nothing or as a swindler.

The Bee-moth was first introduced into this county from Europe, about the commencement of the present century, and it was in all probability imported with the common bee-hive. There are two broods of the moth each year, the first brood appearing in May and June, and the second, which is the most numerous, in August. During the day time, these moths remain quietly ensconced in some angle of the hive, but as night approaches, they become active, and the female uses her best endeavors to get into the hive, her object being to deposit her eggs in as favorable a place as possible. Wire-gauze contrivances are of no avail to keep her out, as she frequently commences flying before all the bees have ceased their work. But even if she were entirely prevented from entering the hive, she could yet deposit her eggs on the outside, or by means of her extensile ovipositor, thrust them in between the slightest joint or crack, and the young worms hatching from them, would readily make their way into the hive. The moment the worm is hatched, it commences spinning a silken tube for its protection, and this tube is enlarged as it increases in size. This worm cuts its channels right through the comb, feeding on the wax, and destroying the young bees on its way. When full-grown, it creeps into a corner of the hive or under some ledge at the bottom, and forms a tough white cocoon, of silk intermingled with its own black excrement as in figure 92, *b*. In due time the moth emerges from this cocoon.

A worm-infested hive may generally be known by the discouraged aspect which the bees present, and by the bottom-board being covered with pieces of bee-bread mixed with the black gunpowder-like excrement of the worm. It must not be forgotten, however, that in the spring of the year, pieces of bee-bread at the bottom of a hive *when not mixed with the black excrement*, is not necessarily a sign of the presence of the worm, but, on the contrary, may indicate industry and thrift. If a hive is very badly infested with the worm, it is better to drive out the bees and secure what honey and wax there may be left, than to preserve it as a moth breeder to infest the apiary. If put into a new hive, the bees may do something, and if they do not, there is no loss, as they would have perished, finally, from the ravages of the worm.

It should invariably be borne in mind that a strong stock of bees is ever capable of resisting, to a great extent, the attacks of the worm; while a starved or queenless swarm is quite indifferent to its attacks. In a common box hive, a good way to entrap the worms after they are once in a hive, is to raise the front upon two small wooden blocks, and to put a piece of woolen rag between the bottom-board and the back of the hive. The worms find a cozy place under the rag, in which they form their cocoons, and may there be found and killed, from time to time. Much can be done in the way of prevention, by killing every morning, the moths which may be found on the outside of the hives. At this time of the day, they allow themselves to be crushed, with very good grace; and if two or three be killed each morning, they would form an important item at the end of the year, especially when we recollect that each female is capable of furnishing a hive with at least 300 eggs. In conclusion, I give it as my conviction that immunity from the ravages of this Bee-worm can only be guaranteed where a thorough control is had of both hive and bees; hence the great importance of the movable frame hive.

THE BEE-KILLER—*Trupanea apivora*, Fitch.

(Diptera, Asilidæ.)

[Fig. 93.]

In the last chapter of his 9th Report, Dr. Fitch describes a fly by the name of the "Nebraska Bee-killer," which he received from Mr. R. O. Thompson, of Nursery Hill, Otoe county Nebraska, and which the latter named gentleman had found preying upon the bee in North Nebraska in the summer of 1864. Mr. Thompson has since removed from Nebraska to North Missouri, and in conversation with him last summer he informed me that he had met with this Bee-killer each year since 1864, and that it seemed to be increasing. At a later day, in a communication to the *Rural World* of September 1[illegible], 1868, he states that it made its appearance in such numbers in North Missouri last summer, that it to a great extent prevented the bees from swarming. I present above at Figure 93 a life-size portrait of this voracious insect, its general color being yellowish-brown or yellowish-gray. This figure will enable its ready recognition, and those who wish a very full and detailed description of it will find it in the Report of Dr. Fitch above referred to. It belongs to the *Asilus* family of two-winged flies which have been very aptly termed the hawks of the insect world. Last July I found thse flies quite common in Mr. Shaw's beautiful gardens in St. Louis, and I watched them by the hour and found to my amazement that though other insects were flying all around, as well as other species of bees, yet they never seized any other species but the common Honey-bee. They capture the bee on the wing, pouncing upon it with lightning-like rapidity; then grasping it securely with their fore legs, they alight upon some plant or even upon the ground, and rapidly suck out the inside of the bee, with the stout and powerful proboscis which is shown in the figure, leaving the empty shell when they get through. Mr. Thompson says that beneath some favorable perch that is near the apiary, hundreds of these bee-shells may be found accumulated in a single day; while he has watched and found that a single fly on one of these perches destroyed no less than 141 bees in that period of time.

The habits of these flies are little known, and until they are better understood no feasible way of protecting the bees from their attacks can be given. Those which are known to haunt the apiary should be captured, and this can best be done by means of a net. It is almost impossible to catch them while on the wing, though as soon as they have settled with their prey they are caught with comparative ease. It will pay to thus catch them for they are doubtless the cause of much of the non-swarming which we hear of.

BENEFICIAL INSECTS.

I have already treated of a number of beneficial insects in connection with the insects on which they prey, and under this head I shall, for the present, only say a few words about

THE REAR-HORSE, *alias* CAMEL-CRICKET, *alias* DEVIL'S RIDING HORSE—*Mantis Carolina*, Linn.

(Orthoptera Mantidæ.)

[Fig. 94.]

This peculiar and predatory insect which is variously known by either of the above names in different localities, is very fortunately quite common in the central and southern parts of Missouri, as well as in most of the Southern States. Its food consists mainly of flies, though it is a most voracious cannibal and will devour its own kind as well as any other living insect that comes within its grasp. I have known it to attack various kinds of butterflies, including the male Bag-worm, grasshoppers, and caterpillars of various kinds, and in one instance a single female devoured eleven living Colorado Potato-beetles during one night, leaving only the wing-cases and parts of the legs. It disdains all dead food, and never makes chase for the living, but silently, patiently and motionless, it watches till its victim is within reach of its fore-arms, and then clutches it with a sudden and rapid motion. Its appearance is really formidable, and its attitude while watching for its prey quite menacing, and on this account it is held in very general and superstitious dread. It is, however, utterly incapable of harming any one; and, as one of our best friends should be cherished and protected.

At Figure 94, above, this insect is represented in the full grown state, *a* showing the female and *b* the male. It will be seen that they differ materially from each other, the male having a long slender body with long wings, while the female has a broad flat body with short wings. Hence, while the male can fly through the air with greater facility than do our grasshoppers, the female is utterly incapable of performing the same feat, and only uses her wings when in battle with one of her own kind, or when pouncing upon her prey, at which time she hoists them very much as a swan hoists his wings when irritated. The difference in the sexes is not apparent till after the third moult, all the young Mantes being very much alike. The general color of the Mantis is grayish-brown though a pale green dimorphous form is quite common. The newly hatched larva is invariably, so far as my observations exten i, light yellowish-brown, though I have seen green individuals after the first moult. The green form is almost entirely confined to the female sex, and seems to be the most common color of this sex when full grown; but it is found likewise, to some extent, among the males, as specimens with green legs and partly green bodies are to be met with, though I have never seen a male that was entirely green. About the beginning of August these Mantes acquire wings, and by the middle of September the female commences to deposit her eggs. These eggs are all glued tightly together in a peculiar mass, and are deposited in all sorts of situations, but principally on the twigs of trees. At Figure 95 two of these egg-masses are represented, natural size, the lower mass showing the most common form, the upper mass illustrating how it conforms to the object on which it is placed. These egg-masses are often found by persons in the winter, though very few are able to conjecture what they really are. On cutting them open the eggs are found to be very systematically arranged and to contain a mucilaginous substance of the color of thin glue.

[Fig. 95.]

The manner in which these eggs are deposited has never been described, and though I have never myself witnessed the operation, I have found the mass while it was yet quite soft and freshly laid, and have dissected the female just before she was about to deposit; and incline to believe that it is gradually protruded in a soft mucilaginous state, being covered at the time with a white, frothy, spittle-like substance which soon hardens and becomes brittle upon exposure to the air. Mr. Parker Earle informs me that he has witnessed the operation, and that he judges it to require about an hour, the eggs being "pumped out, and the entire mass elaborately shaped, with a fine instinct of construction as the process continues."

Between the 10th and 20th of June these eggs hatch into comical-looking little Mantes, in all respects resembling their parent, with the exception that they have no wings; for, with the grasshoppers, crickets, katydids, walking-sticks and roaches, etc., etc., which belong to the same order (*Orthoptera*), they do not undergo any sudden transitions from the masked *larva*, to the quiescent *pupa*, and thence to the winged *imago* state, as do most other insects.

When the young first issue from the egg-mass, they are yet, as with the young of most other *Orthopterous* insects, enveloped in a fine skin which confines their members and prevents free motion. In this condition they look not unlike some of our leaf-hoppers (*Tettigoniæ*,) but as soon as they extricate themselves they begin to show their unfeeling and voracious disposition by attacking and devouring each other. Indeed, those sentimentalists who believe that the worm crushed under foot suffers as much as the man who breaks an arm or a leg, would do well to study the habits of these Mantes. They are so void of all feeling that, the female being the strongest and most voracious, the male in making his advances, has to risk his life very many times, and at last only succeeds in grasping her by slyly and suddenly surprising her; and even then he frequently gets remorselessly devoured. I have seen a female, decapitated, and with her body partly eaten, slip away from another that was devouring her, and for over an hour afterwards fight as tenaciously and with as much *nonchalance* as though nothing had happened.

The eggs may be readily transported from one place to another, and the insect can thus be easily colonized. Mr. Jordon in this way has caused them to increase very much in his home nursery in St. Louis, though he finds some difficulty in protecting the eggs during the winter from the attacks of birds. He considers that as long as he can keep the Mantes sufficiently numerous he will never be troubled with noxious insects.

We know with what fear the hawk is regarded by the great majority of small birds, but that at the same time the common house martin defies and even tantalizes and drives it off. In like manner this Mantis which must be the dread of most flies, is yet defied by a certain class of them, belonging to the same (*Tachina*) family, as that described and figured on page 111, for I have found no less than nine maggots in the body of a living female Mantis, which must have hatched from eggs that had been deposited on her body by one of these flies.

INNOXIOUS INSECTS.

Under this head, I propose to devote a few pages each year to those insects which can neither be considered injurious or beneficial to man, either directly or indirectly. As State Entomologist I feel it my duty to devote my time primarily to the study of those insects that immediately concern the agriculturist, and by thus doing, to save to our great and growing State a portion of that immense sum which is annually lost by insect depredations. At the same time I feel that it will be expected of me to add to our present knowledge of the natural history of the State, by discoveries in my particular branch of zoology. The prosperity of a State does not depend solely on its material wealth, but to a great extent on its mental wealth. KNOWLEDGE—that great interpreter of oracles—moves the world! It enables us to see in the bowels of the unfathomable earth beneath, in the water, in the air, and in the skyey vast above, volumes written by the hand of Omnipotence!

> "To win the secret of a weed's plain heart,
> Reveals the clue to spiritual things,"

And there are few departments of science which offer such food for the mind as does the study of Natural History. It has been truly said that the naturalist has no time for selfish thoughts. Everywhere around him he sees significances, harmonies, chains of cause and effect endlessly interlinked, which draw him out of the narrow sphere of self-lauding into a pure and wholesome atmosphere of joy and felicity.

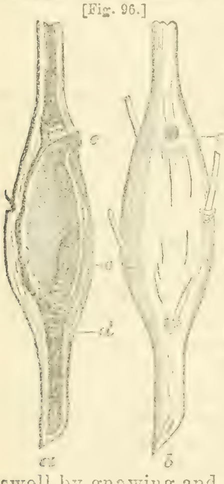
Day by day science is becoming more and more popularized, and before long the necessity of devoting more attention to natural history in our schools and colleges will become apparent. There are few things, for instance, so well calculated to train the minds of children, and at the same time entertain and instruct them as would be a chart illustrating the transformation of insects, and it is with the firm belief that this kind of information will soon be more generally sought for, that I introduce to my readers

THE SOLIDAGO GALL MOTH—*Gelechia gallæsolidaginis*, N. Sp. —Pl. 2, Figs. 1 and 2.

Every body must have noticed the large round galls about the size of a walnut which are found upon the straight smooth stem of the common Golden-rod (*Solidago nemoralis*). There are sometimes two on the same stalk and they are most conspicuous in winter time when the leaves are off the plant. Upon cutting open one of these galls it is found to consist of a pithy solid mass, in the centre of which is a plump white footless maggot. This maggot in due time develops into a two-winged fly, which was long since described by Dr. Fitch as *Trypeta (Acinia) solidaginis.*

The gall which I am now about to speak of, occurs on the same species of Solidago, and in almost equal abundance with the former, though its architect has never hitherto been described. This gall

[Fig. 96.]



which is represented at Figure 96, *b*, is of a very different form from the preceding, being altogether more elongate and narrower, and upon cutting it open it is found to be hollow, and to contain, instead of a white footless maggot, a gray 16-footed caterpillar (*c*), which in time develops into the little moth which is represented with the wings expanded at Plate 2, Figure 1, and with the wings closed at Figure 2. The history of the insect may be thus briefly told.

The moths winter over and may be seen flying in the month of May, in which month I have myself captured a specimen. When the young plants of the Golden-rod are about six inches high the female moth deposits an egg either in the terminal bud, or at the side of the stalk just below it, and the worm hatching from the egg works into the stalk, and causes it to swell by gnawing and thus inducing the secretions towards it. By the beginning of June the gall has just begun to form and at this time upon cutting it open the worm is found to be about $\frac{1}{3}$ grown, and its excrement is as yet all at the upper portion of the gall. As the plant grows, so the gall increases in size, remaining, however, at the same altitude from the ground. By the middle of July both the gall and its maker have attained their full size, and upon opening the former at this season of the year the excrement will be found packed closely at both its ends, and from the small quantity of such excrement (*d*) to be found, it would appear that all but the more solid parts had been absorbed by the plant, it probably acting as a manure to stimulate the growth of the gall. When full grown, the worm measures rather more than half an inch, and it now prepares for changing into the chrysalis state by eating a perfectly round passage-way entirely through the wall of the gall at its upper end. It then protects the orifice with a secretion of liquid silk which hardens and forms a perfect little plug (Fig. 96, *c*,) about 0.04 thick and 0.08 in diameter, and which is so constructed that it cannot be readily displaced from without, as it has a rim on its outer edge. The inner edge, however, is not so rimmed, and the plug can be pushed away from the inside with the slightest effort, for the little tenant when it shall have become fitted to leave its dark and secluded tenement and soar into the air, must needs make its exit through this orifice. Well may we wonder at Nature's handiwork, for what consummate skill, and wonderful instinct—I had almost said forethought—is here exhibited! Can this action be but a blind instinct, or has the larva a premonition of its future etherial imago state and its wants? Who can answer? Our little host, not satisfied with having thus protected the entrance to his home, now lines its passage way, and the walls, with a delicate silken tissue, after which he rests from his labors, and commences to undergo those mysterious transformations, so characteristic of his class. A gall cut in two at this stage of its growth presents the appearance of Figure 96, *b*. In two days' time the little worm has changed to a chrysalis, just $\frac{1}{2}$ inch in length, rather slender and of a shiny mahogany-brown. At the end of about three weeks more the chrysalis grows very dark, and finally the inclosed moth bursts the skin and escapes from the gall.

The first moths usually appear about the middle of August, but as the time of egg-depositing covers a period of over a month, some of the moths have not left till the beginning of October. As winter approaches, the stem seems to grow weak above the gall, and usually bends and droops, while the gall itself shrinks and acquires a whitish weather-washed appearance. It is for these reasons, and from the gall being so near the ground that it does not attract the same attention as the large, round gall of the *Trypeta*.

I have been acquainted with this gall for six years, and have studied it closely during that time. It seems to occur quite generally over the country, and is especially abundant in the West. The first published account that I can find of it in this country is that given by Baron Osten Sacken, in the first volume of the Proceedings of the "Philadelphia Entomological Society," page 369, where he correctly describes it, as well as the puffed carcass of one of the caterpillars (Pl. 2, Fig. 5), caused by a parasitic *Chalcis* fly presently to be described; but he was not acquainted with the maker of the gall. The galls were received by him from Edward Norton, who resides at Farmington, Connecticut. They occur abundantly around Chicago, especially on the north side, in the old cemetery, which is now being converted into Lincoln Park. They are equally abundant around St. Louis, while I have found the same gall on the *Solidago Missouriensis* growing beyond Fort Kearney, in Nebraska, and even there the worm was attacked by the same parasitic *Chalcis* fly mentioned above.

The gall-making insects belonging to the same order (Lepidoptera) as our little moth, are by no means common, and the only other gall of this character with which I am acquainted, at all resembling the one just described, occurs on the stems of *Artemisia compestris* in France, and is produced by the larva of a very different little moth with pale yellow wings shaded with orange, first described by Herrich-Schæffer by the name of *Cochylis hilarana*. This last gall is figured on Plate 1, of the "Annales de la Société Entomologique de France" for 1856, and its history is detailed by M. E. Perris, at pages 33–58 of the same volume. The gall is similar in form, but narrower, with the walls thicker than that of my insect, while the larva is yellowish-white.

GELECHIA GALLÆSOLIDAGINIS, N. Sp.—*Larva.*—Length 0.60. Cylinderical. Color dark dull-brown, without shine. Largest on middle segments; tapering from 4th to head, and from 9th to extremity. Each segment impressed transversely in the middle, thus forming two folds, the thoracic segments having other such folds. Six small piliferous spots, two each side of dorsum and one above stigmata, which, together with the stigmata, are shiny and of a lighter brown than the body. Head and cervical shield light shiny-brown.

Chrysalis.—Length 0.50. Mahogany-brown. Form normal. Blunt at extremity.

Perfect moth.—Average length 0.38. Alar expanse ♀ 0 95, ♂ 0.75. Fore wings deep purplish-brown, more or less sprinkled with carneous. A light carneous band starts from the costa near the base, and curves towards the middle of the inner margin, which it occupies to a little beyond the beginning of the cilia, where it curves upwards towards the tip, reaching only half way up the wing. Here it is approached from above by a somewhat diffuse spot of the same color, which starts from the costa just behind the apex, and runs down to the middle of the wing.

In the plainly marked individuals there is an extra line running from the middle of the inner margin, outwardly obliquing to the middle of the wing, and then back to the inner margin a little beyond where the cilia commence, but in the great majority of specimens this mark is indistinct. Cilia light carneous. Hind wings slate-gray, with the cilia lighter. Antennæ finely annulated with the same two dark and light colors. Head, thorax and palpi light, with a sprinkling of the dark brown. Body dark, with light annulations, The species varies in the distinctness of its markings, and the light parts of the wing appear finely sprinkled with brown under the lens. Male generally smaller than female, with the antennæ proportionately a little longer.

Described from numerous bred specimens.

It seems to resemble *G. longifasciella* of Clemens, in coloration and pattern; but unfortunately our late lamented microlepidopterist, failed almost always to give the measurement of the species he described, and it is impossible to tell how much mine really resembles that species. Yet, as *longifasciella* was described from two mutilated specimens, received from A. S. Packard, jr., and as that gentleman has seen my insect and declared it an undescribed species, there can be little doubt of the fact.

Concealed within its gall, as this worm is, one would naturally suppose that it would rest unmolested from the outside world, and that no parasite could attack it through its green-walled fortress. Such however is not the case. Those oft-quoted lines, written in that spirit of ridicule, in the exercise of which Swift was always happy,

"The little fleas that do so tease,
Have smaller fleas that bite 'em,
And these again have lesser fleas,
And so *ad infinitum*,"

are as applicable to our gall-maker as to most other insects. There are indeed no less than six parasites which attack it, and from many hundreds of galls examined, I estimate that one worm out of every five is thus destroyed. As four of these parasites are new to science, and are all probably confined to this one species of insect, I will briefly describe them.

They all belong to the order HYMENOPTERA, and by far the most common of them is a little fly of a dark metallic green color, with reddish legs, which is represented highly magnified in Plate 2, Figure 6, the hair line below showing the natural size. Its larvæ infest the caterpillar in great numbers, and cause it to swell to three and four times its normal size. After they have absorbed all the juices of their victim, they form for themselves very fine brownish cocoons, which are so crammed together that they give the puffed-up worm the roughened appearance, shown at Plate 2, Figure 5, and prevent the skin from collapsing after they have left, so that it may be found within the gall at any time during the winter. These minute flies all leave the gall through a single minute hole, which must be made by one of their number. They are active little creatures, running nimbly, with their antennæ always bent towards the surface on which they travel. They have a wonderful power of jumping, and are able to leap the distance of a foot so suddenly and rapidly that they are, for the moment, scarcely visible. I have counted over 150 of them in a single caterpillar, and the mother fly must gnaw for herself a passage through the gall, and leisurely insert her batch of eggs in the inmate. This fly belongs to the *Chalcis* family, and may be called the Inflating *Chalcis* fly. The family to which it belongs has scarcely been at all studied in America, and very few species have been described. I therefore leave the species, for the present, undescribed, it apparently belonging to the genus *Pirene*.

Another parasite which infests this caterpillar, is represented in the perfect state at Plate 2, Figure 9, the hair line above showing the natural size. It is a black fly, and its larva, which is often found at the bottom of the gall during the month of August, is a white, footless grub, about 0.24 long, and attenuated at the head. Some of these maggots change to pupæ and become flies in the fall of the year, while others remain in the maggot state till spring. The pupa is whitish, with the members confined and darker. This fly belongs to the same (*Chalcis*) family as the preceding, and to the genus *Eurytoma*. I name it in honor of my esteemed friend, Mr. A. Bolter, of Chicago—an entomologist, as enthusiastic as he is modest, and an indefatigable collector. When I think of the many happy hours we have spent together, and recall our many pleasant hunting grounds, the following pretty lines are ever floating in my mind:

> "I long to walk by the meadow's brook,
> To visit the fields and the woods once more,
> To loiter long in the shady nook,
> And tread the paths I have trod before;
> Or, under the spreading branches to lie
> And watch the clouds in the azure sky."

Annexed will be found a full description of this parasite:

EURYTOMA BOLTERI, N. Sp.—♀ Length 0.18. Antennæ black, not much longer than the face, perceptibly thicker towards the end, and apparently 10-jointed, though the three terminal joints are almost always confluent. Dimensions and appearance of joints, represented in the annexed Figure 97, *a*. Head and thorax rough-punctured and finely bearded with short, stiff gray hairs. Abdomen about as long as thorax, scarcely so broad, viewed from above, but wider viewed laterally; highly polished, smooth and black, the three terminal segments with minute stiff gray hairs along the sutures; visibly divided into seven segments, the four anterior ones of about equal length, the two following shorter, and the terminal one produced into a point. Legs fulvous with the *coxæ*, thighs and more or less of the shanks blackish-brown. Wings perfectly transparent, glossy, colorless, and with the nerves very faint.

[Fig. 97.]

♂ Measures but 0.14, and differs in the antennæ, being twice as long as the face, in their narrowing towards the tip and in being furnished with whorls of long hairs. The number of joints are not readily made out, and I have consequently presented at Figure 97, *b*, a magnified figure. His body is but half as wide and half as long as the thorax viewed from above, and not quite as broad as the thorax, viewed laterally; it also lacks the produced point of the ♀. His wings are also cut off more squarely and more distinctly nerved.

The third parasite which attacks our gall-maker is represented somewhat enlarged at Plate 2, Figure 7. It is an opaque black fly belonging to the true ICHNEUMON family and apparently to the genus *Hemiteles*. After most of the gall-makers have undergone all their transformations and escaped, some few of the galls are found still ininhabited by the worm. These belated worms contain the larva of this fly, and they are somewhat smaller and paler than are the healthy ones; their life as worms being prolonged by the presence of their enemy within. During the month of September, the parasitic larva leaves the body of the caterpillar, and spins for itself, within the gall, a tough white silken cocoon, in which it remains through the winter, and from which the fly escapes during the following March or April, some of them escaping much earlier than others. This fly I have named in honor of my friend Mr. E. T. Cresson, of Philadelphia, to whom I am indebted for the generic determination of all these parasites.

HEMITELES (?) CRESSONII.—♂—Length 0.25. Black, opaque, head transversely-subquadrate; face clothed with pale glittering pubescence; spot on mandibles, palpi, scape of antennæ in front and the tegulæ, white; eyes large, ovate; antennæ longer than head and thorax, slender, black; thorax closely and minutely punctured; mesothorax with a deeply impressed line on each side anteriorly; scutellum convex, closely punctured, deeply excavated at base; metathorax coarsely sculptured, truncate and excavated behind, the elevated lines sharply defined, forming an irregularly shaped central area, and a triangular one on each side of it, the outer posterior angle of which is prominent and subacute; wings hyaline, iridescent, nervures blackish, stigma large, areolet incomplete, the outer nervure wanting; legs pale honey-yellow, coxæ paler, tips of posterior femora, and their tibiæ and tasri entirely blackish; abdomen elongate ovate, flattened, petiolated, the first segment flat, gradually dilated posteriorly, somewhat shining, and indistinctly longitudinally aciculate; the two following segments opaque, indistinctly sculptured; remaining segments smooth and shining.

A fourth parasite, belonging to the same great ICHNEUMON family, issues from the worm and spins a white silken cocoon, in exactly the same manner as the preceding. From this cocoon at the same season of the year, escapes a fly which is also of very much the same size and appearance, but which belongs to the distinct genus *Microgaster*.

It has hitherto been undiscribed and may be known by the specific name of *gelechia*.

MICROGASTER GELECHIA—Length 0.20 ♂ ♀.—Black, clothed with a short, thin, glittering, whitish pubescence, most dense on the face, which latter is closely punctured; occiput and cheeks shining; mandibles rufopiceous; palpi whitish; eyes pubescent; antennæ as long as the body in ♂, shorter in ♀, 18-jointed; thorax shining, feebly punctured, mesothorax closely and more strongly punctured, with a deeply impressed longitudinal line on each side over base of wings; scutellum smooth and polished, the lateral groove broad, deep, arched and crenulated; metathorax opaque, densely rugose, with a sharp, central, longitudinal carina, and a smooth, flat, transverse carina at base; tegulæ testaceous, wings hyaline, iridescent, apex smoky, nervures blackish, areolet complete, subtriangular, radial nervure indistinct; legs pale honey-yellow, coxæ blackish, pale at tips, middle pair in ♀ concolorous with legs; abdomen with the two basal segments densely rugose and opaque, the remainder smooth and shining; venter more or less varied with pale testaceous.

The galls containing worms that have been victimized by either of these last two parasites are generally small and narrow, indicating that the worm has been sickly and not able to perform its functions in a proper manner, but those containing worms infested with the Inflating Chalcis-fly, first described, are of the normal size, the worm often having completed its passage-way before succumbing to its enemy.

There are two other and larger parasites which attack our little Gall-maker, the one an undescribed species of *Pimpla* and the other an undescribed species of *Ephialtes;* making in all six distinct parasites. Besides these, there is another insect which intrudes upon and often kills him. This last is the larva of some small long-horned beetle, and most likely of some species of the genus *Oberea*, as it greatly resembles the larva of *Oberea ocellata*, Hald., which I have bred from the stems of the Cottonwood. After the parent gall-moth has deposited her egg, and the young worm and its gall have acquired considerable size, the parent beetle of this larva comes along and deposits her egg higher up on the same stem, and the larva hatching from it immediately commences boring downwards till it reaches the gall, where it riots until it has crowded out the proper inhabitant and filled the gall with excrementitious and pithy *debris*. It then continues its descent till it reaches the root, where it continues boring till winter approaches, and where it hybernates in the larva state. Sometimes the gall-maker succeeds in webbing this intruder out, so that he only partially destroys the gall, while at other times the intruder does not reach the gall till the inmate has changed to the chrysalis state; but in the latter case the moth always dies in its endeavors to escape. The vacated galls of this gall-moth afford excellent winter shelter for a variety of insects and spiders, and the common Chinch bug is especially fond of taking up its winter quarters in them.

THE CHICKWEED GEOMETER, *Hæmatopis grataria*, Fabr.—Pl. 2, Figures 18, 19, 20 and 21.

(Lepidoptera Geometridæ.)

At Plate 2, Figure 18, I have figured a very common little moth which may be seen flitting over our meadows and in our gardens during the summer and fall months. It is of a delicate orange color, marked with pink, as in the figure. A number of persons have desired to know whether or not it was injurious, and what its larva fed on, and, as its transformations have been hitherto unknown, I will briefly record them.

The female moths deposit their eggs in rows of about twenty, along the edge of a leaf, or along the stem of the common chickweed (*Stellaria media.*) These eggs (see Pl. 2, Fig. 21) are not quite 0.02 of an nch long and are oval, flattened and depressed near the centre. When first laid they are yellowish-white, but change within two days to a very bright, shiny, red color, between Venetian and vermillion. These eggs hatch in a very short time, frequently within a week, into thread-like worms, with ten legs only and with the habit of looping themselves into all manner of shapes, especially into a circle. In about a month, during hot weather, they acquire their full size, when they are of the form and appearance of Plate 2, Figure 19. They are quite variable in color, being either gray, yellowish-green, or dark brown. They change to chrysalids within a slight web attached to the leaves of their food-plant, and in this state they bear the appearance of Plate 2, Figure 20, the skin being so thin that before the moth escapes the colors of the wings show distinctly through it. There are several broods during the year, and the insect may often be found in all its different states at one and the same time. It probably passes the winter in either the larva or egg state, for I have taken both eggs and half grown larvæ in the beginning of November. In the larva and chrysalis state it is not easily detected, on account of its small size and of its assimilating the color of the food-plant. The larva has furthermore the habit of jerking itself away to a considerable distance when disturbed, especially while it is young.

Hæmatopis grataria, Fabr.—*Larva*—Average length 0.85. Color quite variable; either pale yellowish-green, deep rufous with an orange tint, or of a mixture of gray and cream-color. Minutely punctate all over. Segments 1, 2 and 3, extremely short; 4, longest and widest, having two wrinkles each side, with a dark depression between them; 5, 6, 7 and 8, of equal length; 9, 10 and 11, short, the two former also somewhat wider than the other. Dorsum dark, with a lighter middle line, and a light, somewhat irregular subdorsal line which converges anteriorly and diverges posteriorly of each segment; two dark spots anteriorly each side of the middle line. Sides more or less wrinkled, lighter than dorsum and with a light longitudinal ridge below. Venter variegated with longitudinal marks, and shaded outwardly with deep olive-green in strong contrast with the lateral light ridge. Stigmata minute, black, and placed on an oval swelling at the anterior portion of the segment. Head of the same color as body, with a dark line, edged each side with white, continuing from the thoracic segments.

Chrysalis.—(Plate 2, Fig. 20.) Length, 0.50. Wing sheaths and tip of abdomen pale buff, the middle of the abdomen very light yellowish-green. A purplish dorsal line. Obliquely truncated at the head, having a somewhat triangular appearance, the ventral angle being lengthened into a slightly bifurcate snout. Anal segments quite attenuated, the extremity being also slightly bifurcated. Stigmata small, black and distinct.

THE THISTLE PLUME,—*Pterophorus carduidactylus*, N. Sp., Pl. 2, Figs. 13 and 14.

(Lepidoptera Alucitidæ.)

Having already sketched the history of the Grape Plume, page 137, the larva of which attacks the Grape vine, I will now give the history of another species of the same *genus* whose larva infests the common Thistle (*Cirsium lanceolata*) in order to show how very dissimilar two larvæ may be, which belong to the same genus and greatly resemble each other in the perfect state.

During the month of May the heads of the above named thistle may frequently be found drawn together by silken threads, with some of the leaves frequently dead. On pulling this webbed mass apart from eight to a dozen thick smooth worms may be found, which are of a light straw color with rows of black spots, and the head and tail

[Fig. 98.]

marked as in the accompanying figure. These worms are found of different sizes in the same head, which would indicate that the parent moth either deposits her eggs at different intervals in the same place or that the eggs hatch out irregularly. Towards the end of May they change to pupæ within the burrow which the worm inhabited; these pupæ being of a dull yellow color, without polish, and resembling the pupæ of some long-legged Crane fly (*Tipula*) rather than a moth—see Pl. 2, Fig. 14. In just one week after they have thus changed, the moths escape. This moth, which is represented at Plate 2, Figure 13, is of a tawny yellow color, with a prominent triangular dark spot on the outer third of the front wing, running from the front edge. As it differs from all hitherto described North American species, it may appropriately be called the Thistle Plume.

PTEROPHORUS CARDUIDACTYLUS, N. Sp.—*Larva.*—Average length 0.60. Largest in the middle of body, tapering thence each way. Color light straw-yellow—greener when young. Somewhat darker, partly translucent, dorsal, subdorsal and stigmatal lines. Two lateral rows of black spots, the lower spots rather smaller and placed behind the upper ones. A third row above these, and others along the back, but so small that they are generally imperceptible with the naked eye, except on the thoracic segments, being especially distinct on segment 2. Head small, black, sometimes inclining to brown. Cervical shield black, divided longitudinally in the middle by a lighter line. Caudal plate also black. Segment 11, besides the spots above mentioned, has two transverse black marks, the posterior one the largest. Thoracic legs black, the others of the same color as the body.

Described from 12 specimens.

Pupa.—Average length 0.45. Of form of Plate 2, Figure 14. Soft, dull yellow, with a lateral dusky line, each side of dorsum, and another, less distinct each side of venter. Also dusky about the head and wing-sheaths.

Perfect insect.—Length 0.45; alar expanse 0.80. Front wings bifid, the cleft reaching not much more than ¼ of wing; tawny yellow, with a distinct dark brown triangular spot running from costa to the base of cleft—sometimes a little below it—its posterior margin with a slight concave curve. Three dusky, diffuse longitudinal spots, one placed on the basal third of the wing at costa and frequently reaching along the costa to the triangular spot; one near the interior margin, a little nearer to the base of wing than the last, and one on the outer third of the interior margin. Two light-colored transverse lines across the end of wing, one very near and parallel with posterior margin, the other bordering the triangular spot behind, and curving across the lower lobe towards posterior angle. The space between these two light lines usually darker than the ground-color. Fringes dark with a light margin. Hind wings trifid, the upper cleft reaching a little beyond the middle, the lower one to the base of wing. Color ashy-brown, the lower lobe produced into a dark angular spot about their middle posteriorly. Antennæ, palpi, head, thorax, and body, tawny yellow; legs of the same color with the exception of the tarsi, which are almost white, with alternate dark brown spots, the spines being black, with dusky tips.

ERRATA.

Page 8, line 21, for "being" read "were."
Page 10, line 1, for "Figure 3, ♂" read "Figure 3, ♀."
Page 12, line 29, for "last" read "1866."
Page 12, line 3 from bottom, after "February," add "(1867)."
Page 31, line 15, for "37°" read "38°."
Page 47, line 16, for "far" read "for."
Page 114, line 1, after "insect" read "(*Strietrus frimbriatus*, Say)."
Page 120, line 30, after "Cottonwood" read "(*Pemphigus vagabundus*, Walsh)."
Page 133, line 24 from bottom, for "preceding insect" read "Grape curculio."
Page 134, line 3 from bottom, for "Part V" read "Part VI."
Page 142, under the heading, add "(Lepidoptera, Tortricidæ)."
Page 166, under the heading, add "(Lepidoptera, Tineidæ)."

INDEX.

SECOND ANNUAL REPORT

ON THE

Noxious,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
STATE ENTOMOLOGIST.

JEFFERSON CITY:
Horace Wilcox, Public Printer.
1870.

PREFACE.

To the Members of the Missouri State Board of Agriculture:

GENTLEMEN:—I herewith submit, for publication, my Second Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

For my First Report, I prepared two lithographic plates, a certain number of which were colored. Such plates, when well executed, are an adornment to any work, but they are expensive; and upon conferring with different members of the Board, it was thought best to furnish two such plates for one-half the edition, rather than one plate for the whole edition. The plan has not worked well, however, since many of those persons most interested in the Report, and for whom it is more especially designed, failed to get copies which had plates.

For this Second Report, therefore, I have confined the illustrations to wood. Most of these wood-cuts are executed in the best style of the art, but they cannot possibly show to good advantage on such paper as was used in last year's Report; and the pains taken in the preparation of these cuts, and in hiring the very best engravers the country affords, seems too much like waste of time and means, when their effect is so spoilt by poor ink and poorer paper. If it is in the power of the Board, by proper action, to secure a better quality of paper for this Report, I sincerely hope that such action will be taken; for a clear impression of an insect cut is often absolutely necessary, to enable the general reader to recognize, in the field, the living form of the particular species which it represents.

The cause of Economic Entomology lost one of its greatest champions, and the farmers and fruit-growers of the West, and especially of our sister State, Illinois, suffered an irreparable loss, in the sudden death, on November 18th, 1869, of Mr. Benj. D. Walsh, of Rock Island. At the time of his death, he was State Entomologist of Illinois, and my Associate in the Editorship of the *American Entomologist*, published at St Louis; and I hardly need say that this sad and unexpected fate of my friend has very much increased my own labors. When I add to this the fact that Mr. Walsh was prostrated for over three months last spring and summer, and that Mr. Wilcox, our State Printer, was ready for this Report at an earlier day than I had anticipated; you will not be surprised to learn that several subjects which I had contemplated treating of, have been unavoidably deferred another year.

In order to make the sense of the text plain to every reader, and at the same time to insure scientific accuracy, I shall continue to conform to the rules laid down in the introduction to my First Report—namely, to print all descriptions of merely scientific interest in small type; to use as far as possible a common name for each insect, always adding the scientific appellation in *italics* and parenthesis, so that it can be skipped, if necessary, without interfering in the least with the sense of the sentence; and to give the Order and Family to which each insect belongs, in parenthesis under each heading.

The reader will also bear in mind that the dimensions given, are expressed in inches and the fractional parts of an inch, 0.25 thus implying a quarter of an inch; and that the sign ♂ is an abbreviation for the word male, the sign ♀ for female, and the sign ☿ for neuter.

My grateful acknowledgments are due to the Superintendents of the Missouri Pacific, South Pacific, Iron Mountain, Hannibal and St. Joseph, North Missouri, and Illinois Central Railroads for free passes over their respective routes.

All which is respectfully submitted by

CHARLES V. RILEY,
State Entomologist.

ST. LOUIS, MO., Dec. 2, 1869.

NOXIOUS INSECTS.

REPORT OF THE COMMITTEE ON ENTOMOLOGY.

READ BEFORE THE MISSOURI STATE HORTICULTURAL SOCIETY, AT ITS ELEVENTH ANNUAL MEETING, BY C. V. RILEY, CHAIRMAN OF THE COMMITTEE.

In the preparation of my Annual Report, I have dwelt in detail on many insects that have attracted attention during the year, either by their injuries or benefits. In that Report numerous illustrations will be used to appeal to the eye of the reader, and as it will be published in the same volume with your transactions, I deem it superfluous at the present time to dwell on the natural history of any one insect. Permit me, therefore, to cursorily refer to a few of the prominent entomological events of the year, and afterwards to make a few generalizations, which it is hoped will prove of some little interest and value.

The year 1869 may be set down as one in which our crops, as a general thing, have suffered less than usual from insect depredations. At least such has been the case in Missouri, and, judging from extensive correspondence, the same statement would hold true of most of the northern and middle States of the Union.

True, the Army-worm (*Leucania unipuncta*, Haw.), and the Grain Plant-louse (*Aphis avenæ*, Fabr.), appeared in many parts of the State in sufficient force to do considerable damage, and these two insects may always be expected in a tolerably wet year that was preceded by a very dry one. But most insects, and especially those which afflict you as horticulturists, have behaved exceedingly well, though it is difficult to say whether we are to attribute this good behavior on their part, to the increased knowledge of their habits which has been disseminated among those who have to deal with them, or to the more potent and unalterable workings of Nature.

The Chinch Bug, which in the dry summer of 1868, committed such ravages upon our grain crops in many portions of our State, and especially in the southwest, was scarcely heard of in 1869, after the copious rains which characterized the past summer commenced to shower down. The Apple Worm, or Codling Moth has been altogether less injurious than it was the year before, and in Adair, Buchanan, Cooper, Callaway, Cass, Lewis and Polk counties, especially, and probably all over the State, our orchards have been loaded with fair fruit. This result was predicted by the writer, and may be attributed principally to the scarcity of the insect, resulting from the partial failure of the apple crop in 1868; but in some part to the improved methods of fighting the foe. For, as in our civil strifes, we introduce improvements in the machinery which is to slay the opposing armies, so in this progressive age, we believe in introducing machinery to battle with our liliputian insect hosts, whenever it is available. And the experience of the past year proves, that to destroy this insect, old pieces of rumpled rag or carpet placed in the crotch of a tree, are to be preferred to the hay-bands wrapped around it, because it requires altogether less time to place the rags in their place than to fasten the hay-band; and the worms which spin up in them can be killed by wholesale, either by scalding the rags or by pressing them through the wringer of a washing machine.

Owing to the severe drouth of 1868, which was unfavorable to its successful transformations, that dreaded foe of the fruit-grower, the Plum Curculio, was scarce in the early part of the season, and our plum and peach trees set a fuller crop than they had done before for years; but the subsequent moist weather was favorable to the underground evolutions of this little pest, and the new brood appeared in great numbers about the end of June and beginning of July, when they did much damage to stone-fruit and some damage to pip-fruit by the gougings which they made for food. As stated in an essay read before the State meeting of our Illinois horticultural friends, I have discovered a little cannibal in the shape of a minute yellow species of *Thrips*, which destroys vast numbers of the "Little Turk's" eggs; and let us hope, that by attacking the Curculio in its most vulnerable point, this *Thrips* may in the course of a few years reduce the numbers of the Curculio, as the ladybirds have done with the Colorado Potato-bug, or as the minute mite (*Acarus mali*) is known to have done with the common Oyster-shell Bark-louse of the Apple. The eggs of the Apple-tree Plant-louse (*Aphis mali*) which last winter so thickly covered the twigs of the apple trees in many orchards, hatched and produced a prodigious number of lice as soon as the buds commenced to burst. In this immediate neighborhood they were soon swept away, however, by their cannibal insect foes, and by insectivorous birds, such as the warblers, etc.; but a physiological fact connected with this insect has been developed this year by Dr. E. S. Hull, the able Illinois State Horticulturist, which is of such importance that I cannot pass it over even in this brief report. He has ascertained that we suffer from the injurious punctures of their little beaks long after the lice themselves have disappeared. In fact, he has proved to his own satisfaction that the so-called "scab" in apples, which prevailed to such an alarming extent last year, and rendered thousands and thousands of bushels valueless for market purposes, is actually caused by the punctures of these lice. I said that the doctor had proved this matter "to his own satisfaction," because I believe that caution requires that we should not consider it as an established fact until all objections to it can be dispelled. Personally I have made no observations on this matter, but the facts in the case all add weight to Dr. Hull's theory, if such it can be called. Hitherto the cause of the "scab" on apples has been involved in mystery. It was supposed to have a fungoid origin; yet an examination will show that the scabby appearance is not caused by any live fungus, but by arrested growth of the cells which have become corky and cicatrized. The importance of this discovery of Dr. Hull's, should it once be firmly established, cannot well be estimated; for when we have once ascertained the cause of a disease, it need scarcely exist any longer. By destroying the lice we shall prevent scabby apples, and experience teaches that they can be destroyed by a good syringing of tobacco-water. We may expect, in this immediate vicinity, an almost total exemption from "scab" next year, for the apple trees are remarkably free from the minute black bead-like eggs of the Plant-louse with which they were so thoroughly peppered a year ago.

The Tent Caterpillar (*Clisiocampa Americana*) was more abundant than usual in our orchards, and the Tent Caterpillar of the Forest (*Clisiocampa sylvatica*) also appeared in great numbers both on our orchard and forest trees.

A worm which I have called the Pickle Worm, (*Phacellura nitidalis*, Cram.) and which had never been publicly noticed before, appeared in immense numbers, and did great damage to our cucumbers and melons by boring into the fruit, but as this insect, with others, will be fully treated of in my forthcoming Report, I will pass on to a more general subject.

> "The pebble in the streamlet scant,
> May turn the course of many a river;
> The dew-drop on the infant plant,
> May warp the giant oak forever."

In no department of science does the old proverb "prevention is better than cure," apply with such force as in that of Economic Entomology. In my studies and observations I have often been struck with the fact that many of our very worst insect enemies have been introduced from abroad, and that if this subject of Economic Entomology had been better understood and appreciated fifty years ago, and the proper measures had been taken to prevent the introduction of these pests, we should at present be free from the curse of the great majority of them. We have, indeed, plenty of Native American insects, which have become great pests to the cultivator of the soil, on account of the artificial state of things which he induces. In a state of Nature, a given species of plant, in its struggle for existence, is scattered promiscuously over a certain extent of country, and the particular insect or insects which feed upon that plant, have to search for it over a comparatively extensive surface, and their multiplication is consequently restricted. But the pursuit of horticulture, for instance—which may be succinctly defined as the assembling in tracts of greater or less extent, of one species of plant at the expense and exclusion of others—causes the particular insects which feed upon that plant, to multiply unduly, and we have to use that same intelligence in subduing these insects, which we employ in producing the artificial results which caused their increase. In the normal state of things insects never increase unduly; but, on the contrary, always act as Nature's most faithful servants, and accomplish a most important work in her economy. Yet, for reasons explained above, they naturally become our enemies, and we should suffer from the depredations of our indigenous species, even though no foreign ones had been imported. But we have altogether more than our share of these insect depredators, and so truly is this the case, that insects which attract universal attention, and are considered as very serious evils in Europe, would not be deemed worthy of notice in this country. There, if they lose one-fifth of a given crop, the whole community becomes alarmed; but here the cultivator sometimes considers himself fortunate if he secures the half of his crop from insect ravages, and each State loses annually from fifty to sixty million dollars from this cause alone, though but four States have as yet made any attempt to prevent this serious loss. In order to bring this fact home to you, and to show why we suffer more than do our foreign brethren, I will read a paper, which I have prepared for the *American Entomologist*, on

IMPORTED INSECTS AND NATIVE AMERICAN INSECTS.

If we examine into the history, as detailed in a recent number of our Magazine, (pp. 15–22) of the imported Currant Worm and the Native Currant Worm, we shall find a very curious state of things. These two insects both produce Sawflies, which are so closely allied to each other, that although they are referred to distinct genera by Entomologists, it may be doubted whether the genus (*Pristiphora*) under which the native species is classified be not a mere subgenus of that under which the imported species is classified. Reasoning *a priori*, therefore, we should expect to find a very great similarity in the destructive powers of these two worms, especially as each of them infests the leaves both of the Red Currant and of the Gooseberry. But what are the actual facts? On the one hand we see a Native American species—which must have existed here from time immemorial, feeding on our wild Gooseberries and perhaps on our wild Red Currant, and which yet has troubled our tame Gooseberries and tame Red Currants so very slightly, that it cannot be proved with absolute certainty to have ever done so at all, except in Rock Island county, Ills., and in Scott county, Iowa.*

On the other hand we see a species, only introduced into this country, from Europe, some twelve years ago, which has already almost put a stop to the cultivation of the Gooseberry and Red Currant throughout a large part of the State of New York, the northern borders of Pennsylvania, and the whole of Canada West, and is slowly but surely extending itself in all directions from the point where it was originally imported. What can be the reason of such a wide difference in the noxious powers of two such closely allied insects, feeding on exactly the same plants, but one of them indigenous to America and the other imported into America from Europe? Nor is this the only case of the kind. We can point out at least three other such cases. The Imported Onion-fly (*Anthomyia ceparum*), is a terrible pest to the onion-grower in the East, though it has not yet made its way out West. On the other hand, the Native American Onion-fly (*Ortalis arcuata*, Walker), which is a closely allied species and has almost exactly the same habits, has only been heard of in one or two circumscribed localities in the West, and even there does comparatively but little damage. Again, the Imported Oyster-shell Bark-louse (*Aspidiotus conchiformis*) is a far worse foe to the Apple and certain other fruit trees than our indigenous Harris's Bark louse, (*Asp. Harrisii*), though each of them infests the same species. Finally, the imported Meal-worm beetle (*Tenebrio molitor*) swarms throughout the whole United States, and is a great pest; while the Native American species (*Tenebrio obscurus*), which has almost exactly the same habits, belongs to the same genus, and is of very nearly the same size, shape and color, is comparatively quite rare among us, and is scarcely known to our millers and flour-dealers.

On a careful and close examination, it will be found that almost all our worst insect foes have been imported among us from the

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*In Volume 15 of the *Prairie Farmer*, page 504, a correspondent from Jefferson county, Iowa, states that as early as June 11th, in the year 1865, "a small green worm had taken the lion's share of his currants and gooseberries." This may possibly refer to the Native Currant Worm, which feeds upon gooseberry and currant leaves, but it more probably means the Gooseberry Fruit-worm (*Pempelia grossulariæ*, Packard,) which feeds upon the gooseberries and currants themselves, and which may be found figured and described in our First Missouri Report, page 140. What a vast fund of information is scientifically unavailable, simply because correspondents are so stingy with their pen, ink and paper. Again the editor of the *Farmers' Union*, published at Minneapolis, Minn., says in a recent number of that paper, that several gardens in that vicinity have been for the past few years infested with the Currant worm, and that last year they visited his own garden for the second time, having, the previous year, made sad havoc with the foliage before they were discovered. Now, as there are three perfectly distict worms which attack the leaves of currant bushes, and as the editor contents himself with referring to "THE Currant Worm," the information he imparts is perfectly valueless to the Entomologist, and the practical man may be led astray by the remedies suggested.

other side of the Atlantic. The Hessian Fly* was imported almost ninety years ago; the Wheat Midge about half as long ago; the Bee Moth at the beginning of the present century; the Codling Moth, the Cabbage Tinea, the Borer of the Red Currant, the Oyster-shell Bark-louse, the Grain Plant-louse, the Cabbage Plant-louse, the Currant Plant-louse, the Apple-tree Plant-louse, the Pear-tree Flea-louse, the Cheese-maggot, the common Meal-worm, the Grain Weevil, the House Fly, the Leaf-beetle of the Elm, the Cockroach, the Croton Bug, and the different Carpet, Clothes and Fur Moths, at periods which cannot be definitely fixed. Even within the last few years the Asparagus-beetle has become naturalized in New York and New Jersey, whence it will no doubt spread gradually westward through the whole United States, while the Rape Butterfly was introduced about a dozen years ago, and is rapidly spreading over some of the Eastern States. And only a year ago the larva of a certain Owlet-moth (*Hypogymna dispar*), which is a great pest in Europe, both to fruit-trees and forest-trees, was accidentally introduced by a Massachusetts entomologist into New England, where it is spreading with great rapidity. It is just the same thing with Plants as with Insects. We have looked carefully through Gray's *Manual of Botany*, and we find that—excluding from consideration all cryptogams, and all doubtful cases, and all cases where the same plant is supposed to be indigenous on both sides of the Atlantic—no less than TWO HUNDRED AND THIRTY-THREE distinct species of plants have been imported among us from the Old World, all of which have now run wild here, and many of which are the worst and most pernicious weeds that we have to contend against. In the United States *Agricultural Report* for 1865 (pp. 510–519) will be found a list of ninety-nine of the principal "Weeds of American Agriculture," by the late Dr. Wm. Darlington. Of this whole number no less than forty-three, or nearly one-half, are species that have been introduced among us from the Old World. Among these we may enumerate here, as the best known and the most pernicious, Butter-cups (two species), Shepherd's Purse, St. John's Wort, Cow-cockle, May-weed or Dog-fennel, Ox-eye Daisy, Common Thistle, Canada Thistle, Burdock, Plantain, Mullein, Toad-flax, Bind-weed, Jamestown (Jimson) weed, Lamb's Quarter, Smart-weed, Field Garlic, Fox-tail Grass and the notorious Cheat or Chess. And to these we may add the common Purslane, which, through some strange oversight, has been omitted in Dr. Darlington's catalogue.

It will be supposed, perhaps, since there are about as many voyages made from America to Europe as from Europe to America, that we have fully reciprocated to our transatlantic brethren the favors

*For the sake of the scientific reader, we subjoin here, in their regular order, the scientific names of the insects catalogued by their English names in the text of this paragraph: *Cecidomyia destructor, Diplosis tritici, Galleria cereana, Carpocapsa pomonella, Plutella cruciferarum, Ægeria tipuliformis, Aspidiotus conchiformis, Aphis avenæ, A. brassicæ, A. ribis, A. mali, Psylla pyri, Piophila casei, Tenebrio molitor, Sitophilus granarius, Musca domestica, Galeruca calmariensis, Blatta orientalis, Ectobia germanica, Tinea tapetzella, vestianella, pellionella, &c.; Crioceris asparagi, Pieris rapæ and Hypogymna dispar.*

which they have conferred upon us, in the way of Noxious Insects and Noxious Weeds. It is no such thing. There are but very few American insects that have become naturalized in Europe, and even these do not appear for the most part to do any serious amount of damage there. For example, on one or two occasions single specimens of our Army-worm Moth (*Leucania unipuncta*) have been captured in England; but the insect has never spread and become ruinously common there, as it continually, in particular seasons, does in America. Our destructive Pea-bug (*Bruchus pisi*) has also found its way to Europe; but although it is met with in England, and according to Curtis has become naturalized in the warmer departments of France, Kirby and Spence expressly state that it does not occur in England "to any very injurious extent," and Curtis seems to doubt the fact of its being naturalized in England at all.* Again, the only species of White Ant that exists within the limits of the United States, (*Termes frontalis*), has been known for a long time to be a guest at the Plant-houses of Schönbrunn, in Germany; but is not recorded to have ever as yet spread into the surrounding country. As to our American Meal-worm (*Tenebrio obscurus*), Curtis states that it has been introduced into England along with American flour, and that it is sometimes abundant in London and the provinces;† but Kirby and Spence say not one word about it, and it seems to be confined to the English sea-ports and the places where American flour is stored, without spreading into the adjacent districts.

A very minute yellow ant, however, (*Myrmica molesta*), which is often very troublesome with us in houses, has, according to Frederick Smith, "become generally distributed and naturalized" in houses in England; and Kirby and Spence state more specifically, that "it has become a great pest in many houses in Brighton, London and Liverpool, in some cases to so great an extent as to cause the occupants to leave them."‡ As to our Chinch Bug, our Curculio, our Plum Gouger, our two principal Apple-tree Borers, our Canker-worm, our Apple-tree Tent-caterpillar, our Fall Web-worm, our Peach-tree Borer, and our other indigenous pests among the great Army of Bad Bugs, nobody ever yet found a single one of them alive and kicking on the other side of the Atlantic. And with regard to Plants, the only two American plants that we know to have become so firmly established in Europe as to be a nuisance there, are an American aquatic plant, the common Water-weed (*Anacharis canadensis*), which has choked up many of the canals in England, and our common Horse-weed, or Mare's tail as it is called in the West, (*Erigeron canadense*), which has spread from America nearly over the whole world.

Since then, it can be demonstrated by hard, dry facts, that American plants and insects do not become naturalized in the Old World

*Kirby & Spence *Introd.* Letter 6th; Curtis *Farm insects*, p. 358.

†*Farm insects*, p 334.

‡Smith in Stainton's *Entom. Annual* 1862, p. 70, and 1863 pp. 59–62; Kirby & Spence *Introd.*, Letter 8th.

with anything like the facility with which the plants and insects of the Old World are every day being naturalized in America, there must be some cause or other for this singular state of things. What is that cause? It is, as we believe, a simple fact which is pretty generally recognized now as true by modern naturalists, namely, that the plants and animals of America belong, as a general rule, to an old-fashioned creation, not so highly improved and developed as the more modernized creation which exists in Europe. In other words, although this is popularly known as the New World, it is in reality a much older world than that which we are accustomed to call the Old World. Consequently, our plants and animals can no more stand their ground against European competitors imported from abroad, than the Red Indian has been able to stand his ground against the White Caucasian Race. On the other hand, if by chance an American plant or an American animal finds its way into Europe, it can, as a general rule, no more stand its ground there against its European competitors, than a colony of Red Indians could stand their ground in Engl and, even if you gave them a whole county of land and an ample supply of stock, tools, and provisions to begin with. For throughout Animated Nature, as has been conclusively shown by Charles Darwin, there is a continual struggle for existence, the stronger and more favorably organized species overpowering and starving out from time to time their less vigorous and less favorably organized competitors. Hence, it is as hopeless a task for a poor puny, old-fashioned American bug to contend against a strong energetic, highly-developed, European bug, as it would be for a fleet of old-fashioned wooden ships to fight against a fleet of our modern iron-clads.

Let not "Young America," however, be altogether discouraged and disgusted at hearing, that our Animal and Vegetable Creation is more old-fashioned than that of what is commonly known as the Old World. The oldest geological formations, in which the remains of Mammals occur, contain the remains of such mammals exclusively (*Marsupialea*) as bring forth their young only partially developed, and carry those young about with them in a pouch, till the day of complete development and physical "second birth" arrives. In America we have a single genus—the Opossums—that belongs to this antediluvian type. In the three ancient continents they have absolutely none at all. But if in this respect America is more old-fashioned than Europe, Australia is still more old-fashioned than America; for there almost all their mammals possess this remarkable peculiarity; so that if the American creation is somewhat old-fogyish, that of Australia is the very concentrated essence of old-fogyism itself. Consequently, if Europe crows over us as altogether "behind the times," "Young America" can take its revenge by crowing over Australia, as the land of the Kangaroo and the Wombat and other such exploded absurdities of the Mesozoic epoch.

The theory advanced in the above paper, may meet with some objectors, although I confidently believe in the inference there stated of the relative advancement and improvement of the flora and fauna of the two continents. But there is another reason why the insects which are imported into this country multiply at a prodigious rate, and soon acquire herculean power of doing harm, though they may never have stepped beyond the limits of propriety in their own native home—a reason too palpable and evident to savor of the theoretical. It is, that whenever an injurious insect is introduced in our midst, as a general rule the particular parasite or parasites which kept it in check abroad, are not introduced with it. In consequence, the foreigners, unaccompanied by the usual *gens d'armes*, throw off all restraint and play the deuce with our crops; just as the rats and mice will take possession of, and overrun a house, if not restrained by human or by feline agencies.

Sometimes, as in the case of the Imported Currant-worm, the noxious insects introduced from the old world are attacked by native American parasites, but as I believe the parasites of European nativity to be, as a rule, more energetic and vigorous than our indigenous ones, it would be advisable even in such a case, to import in addition such species as prey upon it in Europe. But in the case of the Wheat Midge which has actually flourished among us for almost half a century without a single parasite of any kind whatever infesting it from one end of the country to the other, it is sheer folly and cupable shiftlessness not to import among us from the other side of the Atlantic some one or all of the three different *Chalcis* flies which are known to check it throughout all Europe. And so with other insects which are known to be unaccompanied with the parasites which attack them abroad. Years and years ago Dr. Fitch demonstrated in print the policy of such a step; but bugs and bug-hunters are so very generally the subject of festive ridicule among the high and low vulgar, that hitherto the recommendation of the State Entomologist of New York has met with no practical response.

Now no one will fail to understand the force of the old proverb already quoted, after listening to these facts. Let us profit by the experience of the past, and while battling with those foes which are already in our midst, let us keep a watchful eye, and be on our guard ready to crush any new plague that may threaten us, before it gets beyond control. Yes, but say you, how is this to be accomplished? Can it be done by the government? Yes, in some cases; as for instance in the importation of parasites, government aid should be solicited. If, in 1860, when the Asparagus Beetle (*Crioceris asparagi*, Linn.) was first introduced on to Long Island, the Legislature of the State of New York had taken proper action in the matter, the insect might have been stamped out of the island at the trivial expense of a few hundred dollars, instead of being allowed to multiply, as it did, to such an extent as to occasion a dead loss of some fifty thousand dollars in a single county, and of spreading from the island into the adjoining country. Quite recently a weevil (*Bruchus granarius*) which does immense damage to peas and beans and some other plants in Europe, was introduced into New York in some pods which a certain gentleman presented to the New York Farmers' Club, and if the proper steps are at once taken, it may yet be prevented from spreading through the country.

In Europe vast sums have been expended in founding professorships of Economic Entomology in the various agricultural colleges, and in conducting elaborate experiments on the best means of checking and controlling these tiny foes. But the entire sum expended by Congress or by our various State Legislatures for this purpose, from the Declaration of Independence to the year of our Lord 1869, cannot exceed ninety or one hundred thousand dollars, or about one thousand dollars a year. Yet the annual damage done by insects within the limits of the United States cannot be less than three hundred million dollars. Indeed, it is but quite recently that the people, from necessity, have awakened to the importance of the subject. We now have an Entomologist connected with the Department of Agriculture at Washington, and, with proper care, he can be of inestimable service to the country, in preventing the introduction of noxious insects. It is not noxious weeds alone, such as the Canada thistle, which are sent broadcast over the land by the distribution of uninspected seeds; but noxious insects are very frequently distributed in the same way. We have the highest authority, Dr. J. L. LeConte, of Philadelphia, for the statement, that before the Entomologist received his appointment, a noxious beetle, *Rhizopertha pusilla*, which has now become naturalized here, was originally introduced into this country in wheat from the Patent Office.

Therefore, there can be no doubt that much may be done at headquarters. That government aid cannot be of any avail in the great majority of instances, however, is equally apparent to those who have studied this question; and we must trust to a more thorough dissemination of such information as will enable each individual to protect himself. Much is being done in this direction by means of State Reports, through the *American Entomologist*, and through our various agricultural and horticultural journals; but much yet remains to be done. We must bear in mind that by enlightening our neighbors, we are helping ourselves, and, as horticulturists, we should urge that more attention be paid in our colleges, and especially in those of an Industrial nature, to the study of the Natural Sciences.

In my First Report, I have shown how the Oyster-shell Bark-louse, though perfectly able to live in the northern part of this State, is yet unknown there; and I tremble, lest some one in carelessness or ignorance should, introduce this dreaded plague of the apple grower into that section, from some Eastern or Northern nursery. Every tree received from a distance should be examined from "top to stern," as the sailors say, before it is planted, and all insects, in whatever state they may be, destroyed. There can be do doubt that many of our worst insect foes may be guarded against by these precautions. The Canker-worm, the different Tussock-moths or Vaporer-moths, the Bark-lice of the Apple and of the Pine, and all other scale insects (*Coccidæ*), the Apple-tree Root-louse, etc., are continually being transported from one place to another, either in earth, on scions, or on the roots, branches, and leaves of young trees; and they are all possessed of such limited powers of locomotion, that unless transported in some such manner, they would scarcely spread a dozen miles in a century.

In the Pacific States, fruit-growing is a most profitable business, because they are yet free from many of the fruit insects which so increase our labors here. In the language of our late lamented Walsh, "although in California the Blest, the Chinese immigrants have already erected their joss houses, where they can worship Buddha without fear of interruption, yet no 'Little Turk' has imprinted the crescent symbol of Mahometanism upon the the Californian plums and the Californian peaches." But how long the Californians will retain this immunity, now that they have such direct communication with infested States, will depend very much on how soon they are warned of their danger. I suggest to our Pacific friends that they had better "take the bull by the horns," and endeavor to retain the vantage ground they now enjoy. I also sincerely hope that the day will soon come when there shall be a sufficient knowledge of this subject throughout the land, to enable the nation to guard against foreign insect plagues; the State against those of other States, and the individual against those of his neighbors.

THE CHINCH BUG—*Micropus leucopterus*, Say.

(Heteroptera, Lygæidæ.)

[Fig. 1.]

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Few persons will need to be introduced to this unsavory little scamp, but, lest perchance, an occasional reader may not yet have a clear and correct idea of the meaning of the word Chinch Bug, I represent herewith (Fig. 1) a magnified view of the gentleman. The hair-line at the bottom shows the natural size of the little imp, and his colors are coal-black and snow-white. He belongs to the order of Half-winged Bugs (HETEROPTERA), the same order to which the well known Bed Bug belongs, and he exhales the same loathsome smell as does that bed-pest of the human race. He subsists by sucking, with his sharp-pointed beak, the juices of our cereals, thereby causing them to shrink and wither, and not by gnawing or biting their substance, as many persons suppose. Insignificant as is the minute puncture of a single individual, yet these insects often appear in such countless numbers as to bleed to death whole fields of grain by their myriad beaks.

If the Western Fruit-grower is asked, what particular insect is the most difficult for him to combat, and the most destructive to his crops, he will probably answer "The Curculio." If the same question is put to the Western Grain-grower, he will infallibly reply "The Chinch Bug." And he will be in the right. The Wheat-midge—popularly known in the West as the "Weevil" or the "Red Weevil"—does a considerable amount of damage, in particular years and in particular localities, by its little legless orange-colored lava sucking away the sap from the growing kernel of wheat. The Hessian Fly—often called simply "the Fly"—injures the wheat by the maggot that produces it living between the stem and the sheath of the blade, and intercepting the sap before that sap can reach the ear. The Grain Plant-louse, easily distinguished from the above two little pests by its long sprawling legs, has in certain years somewhat injured the small grain in the West by accumulating, first on the growing stem and afterwards on the ear, and abstracting the sap with its long pointed beak. There are also, in all probability, several minute Two-winged Flies, which do more or less injury to the growing grain by their larvæ breeding in the stem, the natural history of one of which, the American Meromyza, was given for the first time in my First Report (pp. 159–61). The larva of an unknown moth, which burrows upwards and downwards in the stem of oats, and probably of wheat also, causing the ear to become prematurely white and the kernel to be entirely blasted, also in some years does considerable damage. The White Grub, the Wire-worm, and certain Cut-worms take a certain per centage of the young grain, almost as soon as it peeps out of the ground. But undoubtedly the meanest bug, out of the whole crowd of the multifarious insect-foes of the grain-growing farmer, is the Chinch Bug. He is not satisfied with taking a field here and a field there, and sparing the remainder. But when his time comes—and in mercy to the Western Farmer we are not cursed every year with this little savage—he sweeps the whole country with the besom of destruction. The Wheat-midge, the Hessian Fly, and the Grain Plant-louse, destructive as they are to small grain, yet spare our corn. If they take the good white wheaten bread out of our mouths, they yet leave us an ample supply of corn-dodgers. But the Chinch Bug makes a clean sweep, whenever he gets the upper hand of us. He "goes the entire hog." Nothing in the way of grain comes amiss to him. He is not dainty, not he! Whenever he gets a chance to spread himself, he first of all at one fell swoop destroys the small grain, and then fastens his liquorish beak upon the corn and takes that also.

PAST HISTORY OF THE CHINCH BUG.

The first record we have of the prevalence of the Chinch Bug was in the old Revolutionary times in North Carolina, where it was confounded with the Hessian Fly, an insect just then imported from Europe into the United States. Ever since those times it has been an epidemic pest, in particular years, in North and South Carolina and in Virginia. The great American entomologist, Thomas Say, in 1831, when he had been residing in Indiana for six years, was the first to name and describe it scientifically. He states that he "took a single specimen on the Eastern shore of Virginia;" whence we may reasonably infer that it was then either unknown or very rare in Indiana, and probably also in the other Western States. In Missouri it did considerable damage as early as 1854, for Jas. Pleasant of Fox Creek, St. Louis county, informed me that he had known it since that year, and that he had been previously acquainted with it in Virginia. Wm. M. Beal of Edina, Knox county, writes that it has existed and done more or less damage there since 1856, though it has scarcely been heard of since 1865. Mr. A. H. Roberts of Gray's Summit, Franklin county, informs me that it has not been in that neighborhood more than eight or ten years, and Mr. C. S. Jeffries, of Boles' post office in the same county, never heard of it till about fifteen years ago, though he has lived there for the last fifty years.

If proper records existed, we should doubtless find that it attracted attention in Missouri at a much earlier day, for in Illinois it was noticed as long back as 1840, in Hancock county, where it was absurdly supposed to have been introduced by the Mormons of Nauvoo, and was called the "Mormon louse"

In 1868, owing to the great drouth, this insect, as I have stated elsewhere, was quite injurious in many sections of our own State, and especially in the southwest. In the extreme northern portion they began to attract attention about the first of May, but the wet weather that occurred about that time caused them to disappear. In the more central counties the earliest sown wheat suffered but little from their depredations, though that which was sown later, was reduced about one-third. The conditions being favorable, they rapidly increased during the Summer, and in the fall, the second brood was so numerous that great fears were entertained for the safety of the crops of 1869. Let us be thankful, however, that the excessive rains of last spring and summer, though deplored and regretted by many, had the effect to so thoroughly drown out these little pests, as to make them comparatively harmless; for the only place in which I heard of their doing serious harm was at Tinney's Grove in Ray county. Seeming misfortune is often a blessing in disguise, and though the corn crop was lessened by the heavy rains, the wheat crop in all probability would have suffered far worse, had the season been dry and favorable to the increase of this, the greatest insect foe of the wheat-grower.

We may safely conclude that the Chinch Bug has always existed in Missouri, in small numbers; but that it did not multiply to an injurious extent until the grains began to be cultivated on an extensive scale. At all events, we know from the evidence of Dr. Harris and Dr. Fitch, that it existed long ago in exceedingly small numbers in New York, and even in Massachusetts. What the causes may have been, that thinned out the numbers of this insect in former times in the West, is another question. In former times, the great bulk of these bugs were probably destroyed every winter by the prairie fires, and, as cultivation has extended in consequence of the country being gradually settled up, and less and less prairie has been annually burnt over, the number that has survived through the winter to start the next year's broods has annually become greater. If these views be correct, we may expect them, unless more pains be taken to counterwork and destroy them, to become, on the average of years, still more abundant than they now are, whenever prairie fires shall have become an obsolete institution; until at last Western farmers will be compelled, as those of North Carolina have already several times been compelled, to quit growing wheat altogether for a term of years.

It may be very reasonably asked, why the Chinch Bug does not increase and multiply in Massachusetts and New York, seeing that it existed there long ago, and that there are, of course, no prairie fires in those States to keep it in check. The answer is, that the Chinch Bug is a Southern, not a Northern species; and that hundreds of Southern species of insects, which on the Atlantic seaboard only occur in southerly latitudes, are found in profusion in quite a high latitude in the Valley of the Mississippi. The same law, as has been observed by Professor Baird, holds good both with Birds and with Fishes.*

NATURAL HISTORY OF THE CHINCH BUG.

In the four great and extensive Orders of Insects, namely, the Beetles (*Coleoptera*), the Clear-winged Flies (*Hymenoptera*), the Scaly-winged Flies (*Lepidoptera*), and the Two-winged Flies (*Diptera*), and in one of the four small Orders in its restricted sense, namely, the Net-winged Flies (*Neuroptera*), the insect usually lies still throughout the pupa state, and is always so far from being able to eat or to evacuate, that both mouth and anus are closed up by membrane. In the remaining three small Orders, on the contrary, namely, that of the Straight-winged Flies in its most extensive sense (*Orthoptera* including *Pseudo-neuroptera*), the Half-winged Bugs (*Heteroptera*) and the Whole-winged Bugs (*Homoptera*), the pupa is just as active and just as ravenous as either the larva or the perfect

* Silliman's Journal, xli, p. 87.

insect, and the little creature never quits eating as long as the warm weather lasts, except for a day or so while it is accomplishing each of its successive three, four or five moults. As the Chinch Bug belongs to the Half-winged Bugs, it therefore continues to take food, with a few short intermissions, from the day when it hatches out from the egg to the day of its unlamented death.

Most insects—irrespective of the Order to which they belong—require 12 months to go through the complete circle of their changes, from the day that the egg is laid to the day when the perfect insect perishes of old age and decrepitude. A few require 3 years, as for example the Round-headed Apple-tree Borer (*Saperda bivittata*, Say) and the White Grub which produces the May-beetle (*Lachnosterna quercina*, Knoch.) One species, the Thirteen-year Locust (*Cicada tredecim*, Riley), actually requires 13 years to pass from the egg to the winged state; and another, the Seventeen-year Locust (*Cicada septemdecim*, Linn.) the still longer period of 17 years. On the other hand there are not a few that pass through all their three states in a few months, or even in a few weeks; so that in one and the same year there may be 2, 3 or even 4 or 5 broods, one generated by the other and one succeeding another. For example, the Hessian Fly (*Cecidomyia destructor*, Say), the common Slug-worm of the Pear (*Selandria cerasi*, Peck), the Slug-worm of the Rose (*Selandria rosæ* Harris), the Apple-worm and a few others, produce exactly two generations in one year, and hence may be termed "two-brooded." Again, the Colorado Potato-beetle in Central Missouri is three-brooded, and not improbably in more southerly regions is four-brooded. Lastly, the common House-fly, the Cheese-fly, the various species of Blow-flies and Meat-flies, and the multifarious species of Plant-lice (*Aphis*) produce an indefinite number of successive broods in a single year, sometimes amounting in the case of the last-named genus, as has been proved by actual experiment, to as many as nine.

As long ago as March, 1866, I published the fact that the Chinch Bug is two-brooded in North Illinois (*Practical Entomologist*, I, p. 48), and I find that it is likewise two-brooded in this State. and most probably in all the Middle States. Yet it is quite agreeable to analogy that in the more Southern States, it may be three-brooded. For instance, the large Polyphemus Moth is single-brooded in the Northern and Middle States, and yet, two broods are sometimes produced in this State, while in the South it is habitually two-brooded. Again, the moth known as the Poplar Spinner, (*Clostera Americana*, Harris), is stated by Dr. Harris and Dr. Fitch to be only single-brooded in Massachusetts and New York, the insect spinning up in September or October, passing the winter in the pupa state, and coming out in the winged form in the following June. But Dr. Harris—no doubt on the authority of Abbott—states that "in Georgia this insect breeds twice a year;"* and I have proved that it does so breed in Missouri, having

Injurious Insects, p. 434.

now (Dec. '69) a number of cocoons which were formed by a second brood of larvæ. It is quite reasonable, therefore, to infer that the Chinch Bug may produce even more than two broods in the more Southern States.

It is these two peculiarities in the habits of the Chinch Bug, namely, first, its continuing to take food from the day of its birth to the day of its death, and secondly, its being either two-brooded or many-brooded, that renders it so destructive and so difficult to combat. Such as survive the autumn, when the plants on the sap of which they feed are mostly dried up so as to afford them little or no nourishment, pass the winter in the usual torpid state, and always in the perfect or winged form, under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass or weeds or straw, and often in corn-stalks and corn-shucks. In the fall and winter of 1868, I repeatedly received corn-stalks that were crowded with them, and it was difficult to find a stalk in any field that did not reveal some of them, upon stripping off the leaves. I have even found them wintering in the gall made by the Solidago Gall-moth (*Gelechia gallæsolidaginis*), described in the First Report.

In the winter all kinds of insect-devouring animals, such as birds, shrew-mice, etc., are hard put to it for food, and have to search every hole and corner for their appropriate prey. But no matter how closely they may thin out the Chinch Bugs, or how generally these insects may have been starved out by the autumnal droughts, there will always be a few left for seed next year. Suppose that there are only 2,000 Chinch Bugs remaining in the spring in a certain field, and that each female of the 2,000, as vegetation starts, raises a family of only 200, which is a low calculation. Then—allowing the sexes to be equal in number, whereas in reality the females are always far more numerous than the males—the first or spring brood will consist of 200,000, of which number 100,000 will be females. Here, if the species were single-brooded, the process would stop for the current year; and 200,000 Chinch Bugs in one field would be thought nothing of by the Western farmer. But the species is NOT single-brooded and the process does NOT stop here. Each successive brood increases in numbers in Geometrical Progression, unless there be something to check their increase; until the second brood amounts to twenty millions, and the third brood to two thousand millions. We may form some idea of the meaning of two thousand millions of Chinch Bugs, when it is stated that that number of them, placed in a straight line head and tail together, would just about reach from the surface of the earth to its central point—a distance of four thousand miles.

According to the reasoning of Dr. Henry Shimer, of Mt. Carroll, Illinois, who published an interesting paper on this insect in the proceedings of the Academy of Natural Science of Philadelphia for May, 1867, the Chinch Bug takes wing only at its love seasons, which occur in his locality in May and in August. His views on this subject are well set forth in the following paragraph taken from the paper above alluded to:

May 16, 1865, was a delightful, mild, bright, sunny, summer-like day: and I again, for the last time, observed the same highly interesting phenomena, which I have noticed above as occurring after the harvest of 1864—the atmosphere swarming with Chinch Bugs on the wing. This is their spring; that was their autumnal nuptial season—their season of love. These remarkable little creatures prefer to conduct their courtships under the searching gaze of the noonday sun, instead of at the midnight hour. They were so numerous, alighting on the pavements in the village, that scarcely a step could be taken without crushing many of them under foot. In a few days, they had all disappeared; their breeding grounds were chosen, where they could be found in great numbers, often in pairs. I first noticed this disposition of the Chinch Bug to take wing under the promptings of the love passion, about six years ago, in their autumnal love season. At no other time save their love season, twice a year, have I ever seen one Chinch Bug flying. It is quite remarkable that the winged imago, under no other circumstances will even attempt to use its ample wings. No threatening danger, however imminent, whether of being driven over by grain reapers, wagons, or of being trodden under foot, etc., will prompt it to use its wings to escape. I have tried all imaginable ways to induce them to fly, as by threshing among them with bundles of rods or grass, by gathering them up and letting them fall from a height, etc., but they invariably refuse entirely to attempt to use their wings in escaping from danger. The love emotion alone makes them conscious that they are in possession of wings.

I agree entirely with Dr. Shimer as to the facts mentioned in the paragraph, but not as to the conclusions which he deduces. There are many objections to his theory, some of which may be found in the *American Entomologist*, (Vol. I, pp. 172–3).

It is a notorious fact that Chinch Bugs do not all mature at once, and if they took wing only when making their courtships, some of them would be flying during a period of several weeks; and as will be shown presently, there exists a dimorphous short-winged form of the Chinch Bug, which cannot possibly make any such ærial love trips. It seems more agreeable to analogy that they take wing only when they have become so unduly numerous that they are instinctively aware that they must either emigrate or starve. Be this however as it may, the fact of their being as a general rule unwilling to use their wings is well known to every practical farmer.

It has long been known that the Chinch Bug deposits its eggs underground and upon the roots of the plants which it infests, and that the young larvæ remain underground for some considerable time after they hatch out, sucking the sap from the roots. If, in the spring of the year, you pull up a wheat plant in a field badly infested by this insect, you will find hundreds of the eggs attached to the roots; and at a somewhat later period the young larvæ may be found clustering upon the roots and looking like so many moving little red atoms. The egg is so small as to be scarcely visible to the naked eye, of an oval shape, about four times as long as wide, of a pale amber white color when first laid, but subsequently assuming a reddish color from the young larva showing through the transparent shell.* As the mother Chinch Bug has to work her way underground in the spring of the year, in order to get at the roots upon which she proposes to lay her eggs, it becomes evident at once, that the looser the soil is at this time of the year the greater the facilities which are offered for the operation. Hence the great advantage of ploughing land for spring grain in the preceding autumn, or, if ploughed in the spring, rolling it repeatedly with a heavy roller after seeding. And hence the remark frequently made by farmers, that wheat harrowed in upon old corn-ground, without any ploughing at all, is far less infested by Chinch Bug than wheat put in upon land that has been ploughed. There is another fact which has been repeatedly noticed by practical men. This insect cannot live and thrive and multiply in land that is sopping with water; and it generally commences its operations in early spring upon those particular parts of every field where the soil is the loosest and the driest.

The female occupies about three weeks in depositing her eggs, and, according to Dr. Shimer's estimate, she deposits about 500. The egg requires about two weeks to hatch, and the bug becomes full grown and acquires its wings in from 40 to 50 days after hatching.

[Fig. 2.]

There are, as is well known to Entomologists, many genera of the Half-winged Bugs, which in Europe occur in two distinct or "dimorphous" forms, with no intermediate grades between the two; namely, a short-winged or sometimes even a completely wingless type and a long-winged type. Frequently the two occur promiscuously together, and are found promiscuously copulating so that they cannot possibly be distinct species. Sometimes the long-winged type occurs in particular seasons and especially in very hot seasons. More rarely the short-winged type occurs in a different locality from the long-winged type, and usually in that case in a more northerly locality. We have a good illustration of this latter peculiarity in the case of the Chinch Bug, for a dimorphous short-winged form (Fig. 2.) occurs in Canada, and Dr. Fitch describes it from specimens received from the States, as a variety, under the name of *apterus*.

DESTRUCTIVE POWERS OF THE CHINCH BUG.

Few persons in the more Northern States can form a just conception of the prodigious numbers and redoubtable armies in which this insect is sometimes seen in the South and Southwestern States,

*In Dr. Shimer's Paper the dimensions of the egg, as "determined with fine mathematical instruments," are said to be "0.04 inch long and 0.01 inch wide," (p. 99.) This is either a clerical or a typographical error for "0.004 inch long and 0.001 inch wide." Otherwise the egg would be nearly one-third as long as the insect itself; and as Dr. Shimer thinks that every female lays about 500 eggs, this would be something like getting a bushel of wheat out of a quart measure.

marching from one field to another. The following extracts—the first one written in June, 1865, by Dan. F. Rogers to the New York Farmers' Club, and the second from an old number of the *Prairie Farmer*—may seem a little far-fetched, but I have no doubt that both accounts are substantially correct:

There never was a better "show" for wheat and barley than we had here the 10th of June, and no more paltry crop has been harvested since we were a town. Many farmers did not get their seed. In passing by a field of barley where the Chinch Bugs had been at work for a week, I found them moving in solid column across the road to a corn field on the opposite side, in such numbers that I felt almost afraid to ride my horse among them. The road and fences were alive with them. Some teams were at work mending the road at this spot, and the bugs covered men, horses and scrapers till they were forced to quit work for the day. The bugs took ten acres of that corn, clean to the ground, before its hardening stalks—being too much for their tools—checked their progress. Another lot of them came from a wheat field adjoining my farm into a piece of corn, stopping now and then for a bite, but not long. Then they crossed a meadow 30 rods into a 16 acre lot of sorgo, and swept it like a fire, though the cane was then scarce in tassel. From wheat to sorgo was at least sixty rods. Their march was governed by no discoverable law, except that they were infernally hungry, and went where there was most to eat. *Helping a neighbor harvest* one of the few fortunate fields, early sown—and so lucky!—we found them moving across his premises in such numbers that they bid fair to drive out the family. House, crib, stable, well-curb, trees, garden fences—one *creeping* mass of stinking life. In the house as well as outside, like the lice of Egypt, they were everywhere; but in a single day they were gone.

If any Western rustics are verdant enough to suppose that Chinch Bugs cannot be out-flanked, headed off and conquered, they are entirely behind the times. The thing has been effectually done during the past season, by Mr. Davis, Supervisor of the town of Scott, Ogle county, Ill. This gentleman had a cornfield of a hundred acres, growing alongside of an extensive field of small grain. The bugs had finished up the latter and were preparing to attack the former, when the owner, being of an ingenious turn, hit upon a happy plan for circumventing them. He surrounding the corn with a barrier of pine boards set up edgewise, and partly buried in the ground, to keep them in position. Outside of this fence deep holes were dug, about ten feet apart. The upper edge of the board was kept constantly moist with a coat of coal tar, which was renewed every day.

The bugs, according to their regular tactics, advanced to the assault in solid columns, swarming by millions, and hiding the ground. They easily ascended the boards, but were unable to cross the belt of the coal tar. Sometimes they crowded upon one another so as to bridge over the barrier, but such places were immediately covered with a new coating. The invaders were in a worse quandary than that of Butler and Weitzel at Fort Fisher, and, in that state of mind crept backward and forward until they tumbled into the deep hole above said. These were soon filled, and the swarming myriads were shoveled out of them literally by wagon loads, at the rate of thirty or forty bushels a day—and buried up in other holes, dug for the purpose, as required. This may seem incredible to persons unacquainted with this little pest, but no one who has seen the countless myriads which cover the earth as harvest approaches, will feel inclined to dispute the statement. It is an unimpeachable fact. The process was repeated till only three or four bushels could be shovelled out of the holes, when it was abandoned. The corn was completely protected, and yielded bountifully.

HEAVY RAINS DESTRUCTIVE TO THE CHINCH BUG.

As the Chinch Bug, unlike most other true Bugs, deposits its eggs underground, and as the young larvæ live there for a considerable time, it must be manifest that heavy soaking rains will have a tendency to drown them out. The simple fact, long ago observed and recorded by practical men, such as Mr. B. E. Fleharty of North Prairie, Knox county, Ills., that this insect scrupulously avoids wet land, proves that moisture is naturally injurious to its constitution. Hence it was many years ago remarked by intelligent farmers, and we had an illustration of it the present year (1869), that very often when the spring opens dry, Chinch Bugs will begin to increase and multiply in an alarming manner; but that the very first heavy shower checks them up immediately, and repeated heavy rains put an almost entire stop to their operations. It is very true that nearly all insects will bear immersion under water for many hours, and frequently for a whole day, without suffering death therefrom; for although animation is apparently suspended in such cases, they yet, as the phase is, "come to life again." But no insect, except the few that are provided with gills like fishes and extract the air out of the water, instead of breathing it at first hand, can stand a prolonged immersion in water without drowning. And it must be obvious to the meanest capacity, that an insect, such as the Chinch Bug, whose natural home is the driest soil it can find, will have its health injuriously affected by a prolonged residence in a wet soil.

In fact the whole history of the Chinch Bug, from the very earliest records which we have of it, points unmistakably to the fact that a wet season affects it injuriously, and often almost annihilates it. arolina and Virginia, during the dry years which preceded 1840, it had become so numerous that the total destruction of the crops was threatened; but fortunately, unlike its predecessors, the summer 1840 was quite wet and the ravages of the bug were at once arrested. In Illinois and in this State it had increased to an alarming extent during the latter part of the late Rebellion; but the excessive wet summer of 1865 swept them away to such an extent that it was difficult to find any in the fall of that year. So it was again in 1869–70, and so it always has been, and doubtless always will be. It will be well therefore for farmers to bear in mind, that *in a hot, dry season Chinch Bugs are always the worst, and that in a wet season it is impossible for them to do any considerable amount of damage.*

Dr. Shimer, however, is not satisfied with this simple theory. He has gotten up and expounded to the world a new and recondite theory of his own, namely, that in the terrible wet season of 1865, when the Chinch Bug, although in early spring it had appeared in very great numbers, was almost annihilated in the course of the summer, it perished, not as others had foolishly supposed, from the direct operation of the rain, but indirectly through a certain mysterious epidemic disease analogous to the Cholera or the Yellow Fever among human beings. He fully allows that the mortality among the Chinch Bugs was contemporaneous with the wet weather; but he will have it that it was not the wet weather that killed the Bug, as we common folks have always hitherto believed, but that it was his newly-discovered Epidemic Disease. But as in the conjoint article in the *American Entomologist* (I, pp. 174–6) this Epidemic theory was fully considered by my late associate, Mr. Walsh, in his own peculiar style, I shall not dwell upon it here.

CANNIBAL FOES OF THE CHINCH BUG.

As long ago as 1861, Mr. Walsh, in his *Essay upon the Injurious Insects of Illinois*, published facts which tended to show that four distinct species of Ladybirds preyed upon the Chinch Bug.* The first of these four is the Spotted Ladybird (*Hippodamia maculata*, DeGeer, Fig. 3), which also preys upon a great variety of other insects, attacking both the eggs of the Colorado Potato Bug and those of certain Bark-lice; and which is further remarkable for being one of the few insects found both in Europe and in North America.

[Fig. 3.]

[Fig. 4.]

In corroboration of the fact of its preying on the Chinch Bug, I may state, that the Rev. Chas. Peabody, of Sulphur Springs, informs me that he has repeatedly found it so feeding on his farm. The second species is the Trim Ladybird (*Coccinella munda*, Say, Fig. 4), which is distinguishable at once from a great variety of its brethren by having no black spots upon its red wing-cases. The other two are much smaller insects, belonging to a genus (*Scymnus*) of Ladybirds, most of the species of which are quite small and of obscure brown colors, and hard to be distinguished by the popular eye from other beetles, the structure of which is very different, and which therefore belong to very different groups and have very different habits.

In the autumn of 1864 Dr. Shimer ascertained that the Spotted Ladybird which has been sketched above, preys extensively upon the Chinch Bug. In a particular field of corn, which had been sown thick for fodder, and which was swarming with Chinch Bugs, he found, as he says, that this Ladybird, "could be counted by hundreds upon every square yard of ground after shaking the corn; but the Chinch Bugs were so numerous that these hosts of enemies made very little perceptible impression among them."

In the same autumn Dr. Shimer made the additional discovery, that in the very same field of fodder-corn the Chinch Bugs were preyed upon by a very common species of Lacewing-fly, which he

*See *Trans. Ill. St. Agric. Society*, IV, pp. 346–9.

described in January, 1865,* as the Illinois Lacewing (*Chrysopa Illinoiensis*). The description was republished, together with the substance of Mr. Shimer's observations in the *Prairie Farmer*, of Chicago, Ill., accompanied with a non-characteristic wood-cut of the larva, cocoon and imago. At this time Mr. Shimer favored me with two specimens of the perfect insect, and he likewise furnished Mr. Walsh with additional specimens. From these specimens, it is evident that the species is the same as that described long before, by Dr. Fitch, as the Weeping Lacewing (*Chrysopa plorabunda*). In 1868, I found the same species quite numerous in a wheat field belonging to Mr. T. R. Allen, of Allenton, where its larvæ were perhaps feeding on the Chinch Bugs, as they were found to do in North Illinois, by Dr. Shimer.

[Fig. 5.]

The Lacewing flies all bear a striking resemblance to one another, both in size, shape and color; and to convey a correct idea of their appearance, it is only necessary to repeat the annexed drawing (Fig 5.) from my First Report, where a sketch of their natural history will be found (pp. 57–8).† They almost all of them, in the fly state, have a characteristic and disagreeable odor, resembling nothing so much as human ordure.

According to Dr. Shimer, the Weeping Lacewing-fly was not quite as abundant as the Spotted Ladybird among the fodder-corn, but still there were so many of them, that he thought that "there was one or more of them for every stalk of that thickly sown corn." "Every stroke of the cutter," he adds, "would raise three or four dozen of them, presenting quite an interesting spectacle as they staggered along in their awkward, unsteady flight." And he not only actually observed the larvæ preying very voraciously on the Chinch Bugs in the field, but he reared great numbers of them to the mature Fly by feeding them upon Chinch Bugs. His account of the operations of the larva when in captivity is so interesting that I quote it in full:

I placed one of the larvæ in a vial, after having captured it in the field in the very act of devouring Chinch Bugs of all sizes, and subsequently introduced into the vial a number of Chinch Bugs. They had hardly reached the bottom before it seized one of the largest ones, pierced it with its long jaws, held it almost motionless for about a minute while it was sucking the juices from the body of its victim, and then threw down the lifeless shell. In this way, I saw it destroy in quick succession, about a dozen bugs. Towards the last, as its appetite was becoming satiated, it spent five or more minutes in sucking the juices from the body of one bug. After this bountiful repast, it remained motionless for an hour or more, as if asleep. Never for

*Proc. Ent. Soc. Phil., IV, pp. 208–12.

†In that account I stated as a fact which, so far as I was aware, had not been recorded by any previous writer, that the insect issues from the small cocoon in an active sub-imago state, from which, after a few hours, the winged fly emerges, leaving behind it a fine silvery-white transparent skin. I have since found that Dr. Shimer, in the scientific paper already referred to, had previously recorded the very same fact.

a single moment, during the feast, did it pause in the work. When not in possession of a bug, it was on the search for, or in the pursuit of others. It manifested much eagerness in the pursuit of its prey, yet not with a lion-like boldness; for on several occasions I observed a manifest timorousness, a halting in the attack, as if conscious of danger in its hunting expeditions, although here there was none. Sometimes, when two or more bugs were approaching rapidly, it would shrink back from the attack, and turning aside go in the pursuit of others. At length, awakening, it would renew the assault as before. On one occasion, when it was on the side of the vial, two inches up, with a large bug in its mouth, I jarred the vial, so that it fell to the bottom and rolled over and over across the bottom, but holding on to its prey, it regained its footing and mounted up to its former position. Occasionally the Chinch Bugs would hasten to escape when pursued, as if in some degree conscious of danger.

Fig. 6.

I

The Insidious Flower Bug, (*Anthocoris insidiosus*, Say), of which I represent herewith a highly magnified figure, (Fig. 6), may often be found in company with the Chinch Bug, under the husks of ears of corn. It is quite common in Missouri, where I have found it in several different galls, and especially in the Grape-vine Leaf-gall, where it was preying on the lice (*Phylloxera vitifoliæ*), which are the architects of the gall. It has often been mistaken for the Chinch Bug, and was upon one occasion sent to Dr. Fitch, by one of his correspondents, for that veritable Bug. Yet it undoubtedly preys upon the Chinch Bug, as well as upon a variety of other plant-feeding insects, and it therefore becomes very necessary that the farmer should learn to recognize it and distinguish it from the true culprit. It is very true that, practically, it will be found almost impossible to separate the sheep from the goats, and spare the lives of the former while condemning to destruction the unsavory little carcasses of the latter. Still, it will be some comfort to the grain-grower, when at some future day he may discover his small grain or his corn to be alive with Chinch Bugs, to perceive the bright orange-colored larvæ of the Insidious Flower-Bug dodging about among the blood-red or blood-brown larvæ of his bitter foes, and sucking out their life-blood with ravenous avidity; or to discover the little slow-going larvæ of the *Scymnus* group of Ladybirds, with such dense and evenly-shorn masses of short milk-white cottony threads growing out of their entire bodies that they look like little animated flakes of cotton wool, crawling about among the stinking crowd and making many a hearty meal off them, stink they never so badly; or, finally, to watch the lizard-like black and yellow larvæ of the Spotted Ladybird, and the Trim Ladybird, with their short, robust jaws, or the greenish-brown larvæ of the Lacewing-fly, with their long slender sickle-shaped jaws, running rapidly about among the hosts of their enemies, and smiting them hip and thigh without any more mercy than the Amalekites of old experienced at the hands of avenging Israel. He will then know that, even if he is himself powerless to make head against a host of minute foes, as numerous as the sand on the seashore, and as destructive and irresistible as the waves of the great ocean itself, Providence has provided a check upon the unlimited increase of his enemies; and that a Power which is above us all and provides for us all, and which alloweth not even a sparrow to fall to the ground unless by His especial permission, has said to every vegetable-feeding insect, through the mouths of the various Cannibal and Parasitic species which He has appointed to do His work: "Thus far shalt thou go, and no farther; and here shall thy proud hosts be stayed."

The common Quail of the Middle and Western States (*Ortyx Virginiana*) otherwise known as the Partridge in the Northern States has long since been known as a most efficient destroyer of Chinch Bugs, and the fact was some time ago published by myself in the *Prairie Farmer*, and by others in various Agricultural Journals and Reports. We also have the corroborative testimony of Dr Shimer, who is a good ornithologist. In the winter time, when hard pushed for food, this bird must devour immense numbers of the little pests which winter in just such situations as are frequented by the Quail; and this bird should be protected from the gun of the sportsman in every State where the Chinch Bug is known to run riot.

AMOUNT OF DAMAGE DONE BY THE CHINCH BUG.

According to Dr. Shimer's estimate, which may be considered a reasonable one, in the year 1864 "three-fourths of the wheat and one-half of the corn crop were destroyed by the Chinch Bug throughout many extensive districts, comprising almost the entire Northwest." At the average annual rate of increase, according to the United States Census, in the State of Illinois, the wheat crop of 1864 ought to have been about thirty millions of bushels, and the corn-crop about one hundred and thirty-eight million bushels. Putting the cash value of wheat at $1.25 and that of corn at 50 cents, the cash value of the corn and wheat destroyed by this insignificant little bug, no bigger than a grain of rice, in one single State and in one single year, will therefore, according to the above figures, foot up to the astounding total of OVER SEVENTY-THREE MILLIONS OF DOLLARS! Put it as low as we choose, it is still a "big thing;" and it is unnecessary to argue a question any further, when facts and figures speak so plainly.

REMEDIES AGAINST THE CHINCH BUG.

It has long been noticed that the Chinch Bug commences its ravages in the spring from the edges of a piece of grain, or occasionally from one or more small patches, scattered at random in the more central portions of it, and usually drier than the rest of the field. From these particular parts it subsequently spreads by degrees over the whole field, multiplying as it goes and finally taking the entire crop unless checked up by seasonable rains. In newly-broken land, where the fences are new and consequently no old stuff has had time to accumulate along them, the Chinch Bug is never heard of. These facts indicate that the mother insects must very generally pass the winter in the old dead stuff that usually gathers along fences. Hence, by way of precaution, it is advisable, whenever possible, to burn up such dead stuff in the winter or early in the spring, and particularly to rake together and burn up the old corn-stalks, instead of plowing them in, or allowing them, as is often done, to lie littering about on some piece of waste ground. It is true, agriculturally speaking, this is bad farming; but it is better to lose the manure contained in the corn-stalks than to have one's crop destroyed by insects. Whenever such small infected patches in a grain field are noticed early in the season, the rest of the field may often be saved by carting dry straw on to them and burning the straw on the spot, Chinch Bugs, green wheat and all; and this will be still easier to do when the bugs start along the edge of the field. If, as frequently happens, a piece of small grain is found about harvest-time to be so badly shrunken up by the bug as not to be worth cutting, the owner of it ought always to set fire to it and burn it up along with its ill-savored inhabitants. Thus, not only will the insect be prevented from migrating on to the adjacent corn-fields, but its future multiplication will be considerably checked.

A very simple, cheap and easy method of prevention was recommended in the *Prairie Farmer* of April 19th, 1862, by Mr. Wilson Phelps, of Crete, Illinois. It may very probably be effectual when the bugs are not too numerous, and certainly can do no harm:

With twelve bushels of spring wheat mix one bushel of winter rye, and sow in the usual manner. The rye not heading out, but spreading out close to the ground, the bugs will content themselves with eating it, until the wheat is too far advanced to be injured by them. There will, of course, be no danger of the winter rye mixing with the spring wheat.

When Chinch Bugs are likely to march, as they often do, after the fashion of Army-worms, from an infected to an uninfected field, Mr. H. J. Everest, of Stoughton, Dane county, Wisconsin, recommends the following plan, which is stated to have been tried by several persons and found to be perfectly effectual, and which is substantially the same as that referred to on page 23:

Take common fence-boards, six inches or less wide, and run them around the piece, set edgewise, and so that the bugs cannot get under them or between the joints, and then spread either pine or coal tar on the upper edge, and they will not cross it. The tar needs renewing till the edge gets saturated, so that it will keep wet and not dry in any more, and either kind of tar is effectual. Then dig holes close to the boards, about like a post-hole, once in four or five rods, and run a strip of tar from the top of the board to the bottom on the outside opposite the hole, and they will leave the board, and in trying to get around the tarred stripe will slide into the hole, where they will be obliged to remain till they can be buried at leisure, and new holes opened for more victims. It is seldom one has to fence more than one side of a field, but wherever the fence is, it is a sure stop.—*Proc. New York Farmers' Club.*

Finally, when the Chinch Bugs are already in the field which it is proposed to rescue from their clutches, Mr. Michael Hopps, of Lyonsville, Cook county, Illinois, says that he saved a piece of wheat by sowing gas-lime broadcast over it, at the rate of six or seven bushels to the acre; and that the effect was that the bugs immediately left his field, and his crop was saved, while the wheat of his neighbors was nearly ruined by them. He further states that "a neighbor had a field of wheat adjoining his (Mr. Hopps's) cornfield, in which the bugs worked badly. Thinking that, as soon as the wheat was cut, they would emigrate to his corn, he dropped a handful of the gas-lime upon each hill of corn, in the same manner as plaster is often dropped upon corn in the East. The consequence was that the bugs did not attack the corn in the least."—(*Prairie Farmer.*)

But, if gas lime keeps off Chinch Bugs, which may or may not be the case, it appears that coal-tar most certainly will not do so, as the following experiment of Dr. Shimer's proves:

May 26th, 1864.—I saturated some saw-dust with coal-tar, and mixed some quick-lime among it, so that it might be in a good condition for handling, and sowed it thickly broadcast over a portion of my wheat field, where the bugs were very numerous.

May 27th–29th, 1864.—The bugs refuse to leave the part of the field where I sowed the tarred saw-dust, so there is but little hope of driving them from their once chosen grounds, by the seasonable application of strong smelling drugs.

I have known farmers to follow the plan of going through a wheat field badly infested with Chinch Bugs, and with a sickle to cut, here and there, small patches of the wheat which they threw on the ground in the form of a loose irregular shock. The bugs would gather under these cut stalks in great numbers from the standing grain, and could then be destroyed either by crushing or by burning them with straw.

The above remedies are selected as the most likely to prove practically successful, from a mass floating round in the various Agricultural Journals, some of them utterly absurd and irrational, and others of very doubtful use. As to the ridiculous proposal put forth in the Waukegan (Ills.) *Gazette*, in 1865, with a great flourish of trumpets, by one D. H. Sherman of that town; namely, to destroy the Chinch Bugs in the egg state by pickling all the seed wheat; it is sufficient to observe that this insect *never* deposits its eggs upon the kernel of the ripe wheat. Consequently, to attempt to kill Chinch Bug eggs, by doctoring the seed wheat, would be pretty much like trying to kill the nits in a boy's head by applying a piece of sticking-plaster to his great toe. In the old *Practical Entomologist* (I, p. 48), I showed that there were no such eggs in the wheat kernels, which Mr. Sherman himself had sent me, and which he had supposed to be thus infested.

BOGUS CHINCH BUGS.

Few things are more astonishing than the acuteness of perception superinduced by being constantly conversant with some one particular subject. I have often been surprised at the readiness with which nurserymen will distinguish between different varieties of Apple, even in the dead of the year, when there are no leaves, and of course no fruit on their nursery trees. In the same way old practiced shepherds can recognize every individual sheep out of a large flock, though, to the eyes of a common observer, all the sheep look alike. Experienced grain-growers, again, can distinguish at a glance between twenty different varieties of wheat, which the best botanist in the country would fail to tell one from the other; and I have been informed that a miller of many years' standing, as soon as he has shouldered a sack of wheat, knows at once whether it is spring grain or fall grain; while ninety-nine entomologists out of every hundred would probably be unable, on the most careful inspection, to tell the difference between the two, and some might even mistake wheat for rye.

It is not surprising, therefore, that persons who have paid no particular attention to the study of insects, often confound together insects which, in the eyes of the professed entomologist, look as different from each other as a horse does from a cow or a hog. It would, indeed, be little short of miraculous if this were not so; for there are about thirty thousand distinct species of insects to be found within the limits of the United States, and of course in such a vast multiplicity, there must be many strong resemblances.

I will therefore conclude this article on the Chinch Bug, by briefly mentioning several true Bugs, belonging to the same Order of Half-winged Bugs (*Heteroptera*), as that pestilent little foe of the farmer, and which I know to be frequently mistaken for it. The reader will then, by comparing the different figures, see at once how widely they all differ, and by a very little practice, his eyes will become so well educated that he will soon, without any artificial assistance from glasses, be able to distinguish the creatures one from the other, as they crawl or fly about in the almost microscopic dimensions assigned to them by their Great Creator.

One reason, perhaps, why so many different bugs are popularly confounded with the Chinch Bug, is the similarity of their smell. Everybody is aware that Chinch Bugs possess the same peculiarly unsavory odor as the common Bed Bug; and hence when a person finds a small insect that has this obnoxious smell, he is very apt to jump to the conclusion that it must be a Chinch Bug. No mode of reasoning, however, can be more unsafe or unsound. There are hundreds of different species of Half-winged Bugs—the common brown Squash Bug (*Coreus tristis*) for example—that possess this peculiar smell; and what is stranger still, although this smell is more usually met with among the plant-feeders, there are a few of the true Cannibals that possess it to perfection. Among these I may mention the Spined Soldier-bug (*Arma spinosa*, Dallas) whose portrait I here reproduce from my First Report (Fig. 7 *b*); for, as the bitterest enemy of the Colorado Potato Bug, and consequently one of our best friends, he cannot too often be presented, or become too well known. We can well afford to endure his unpleasant odor, when we duly reflect on his kind services. Just think of it, you bitter bug-haters—this little soldier has, beyond all doubt, saved thousands of dollars to the State of Missouri in the last few years, by heroically stabbing and slaying countless hosts of one of your worst enemies! That he should have the bed-buggy odor is not very surprising, since he appertains to a large and extensive group, (the *Scutellera* family) most of the other species belonging to which are plant-feeders. Indeed it is a very general rule, to which I know of but one exception* that the insect in the great *Reduvius* family among the Half-winged Bugs, every one of which is of carnivorous propensities, never have this peculiarly nauseous aroma; and that it is bestowed only upon certain plant-feeding bugs, to protect them no doubt from their insect foes, in the same manner as the skunk is protected from the eagle by his odoriferous tail. Yet while many of the plant-feeding Bugs do have this odor, a good many of them are entirely free from it, and some few of them really smell so agreeably that the fact has been thought worthy to be recorded by entomological writers. Even that detestable pest, already referred to, the common Squash Bug, sometimes emits a pleasant aroma, altogether different from that which it normally gives out; for I have kept this winter, in a separate box, one which emits a most pungent but agreeable smell, very much resembling that of a very ripe, rich pear. But perhaps the most suggestive fact of all is that, notwithstanding the close alliance between the two Orders of Half-winged and Whole-winged Bugs, there is not a single known species of the latter that has ever been known to exhale the bedbuggy effluvium, which is met with in so many species belonging to the former.

[Fig. 7.]

a b

THE INSIDIOUS FLOWER-BUG.—First among the insects frequently mistaken for the Chinch Bug, may be mentioned the Insidious Flower-bug (*Anthocoris insidiosus*, Say) already referred to under the head of "Cannibal Foes of the Chinch Bug." This little Flower-bug has been usually referred by entomologists to the same extensive group (*Lygæus* family) as the true Chinch Bug, though more recent authors have placed it in a distinct group on account of its short three-jointed beak.

THE ASH-GRAY LEAF-BUG.—Second among the Bogus Chinch Bugs may be mentioned the Ash-gray Leaf-bug (*Piesma cinerea*, Say) a

* A shiny black species of *Nabis* (*Nabis marginatus*, Uhler, MS) smells as much like a Bed Bug as the most peaceable Plant-feeder.

small greenish-gray bug of which I present herewith a highly magnified figure (Fig. 8), its true size being about the same as that of the Chinch Bug for which it has been mistaken, though it lacks altogether the conspicuous black and white markings which characterize that

[Fig. 8.]

little grain pest, and really resembles it in nothing but the unpleasant odor which it emits. In the summer of 1868, Col. F. Hecker, of St. Clair county, Illinois (See *Am. Entomologist*, I, p. 19), found an insect, which he mistook for the Chinch Bug, destroying the blossom buds of his grape-vines. Now as the Ash-gray Leaf-bug is known to work in this way on the Grape-vine, and as I found it abundant in Col. Foster's vineyard, on the Iron Mountain Railroad in this State, it was doubtless this species which injured Col. Hecker's vines; for the true Chinch Bug has never hitherto been observed to attack woody plants like the Grape-vine, but confines itself exclusively to herbaceous plants, such as wheat, oats, Indian corn, etc. The Ash-gray Leaf-bug belongs to an entirely different group from the Chinch Bug (*Tingis* family) all the species of which have a short 3-jointed beak, which however differs from that of the 3-jointed beak of the Flower-bugs (*Anthocoris*) by being encased in a groove when not in use. They mostly live on green leaves in all their three stages, after the fashion of plant lice. Like the Chinch Bug, the Ash-gray Leaf-bug hybernates in the perfect state, and may be found in the winter in considerable numbers under the loose bark of standing trees and especially under that of the Shag-bark Hickory.

With the exception of the Ash-gray Leaf-bug, there is no North American species belonging to the genus, that is known to attack fruit trees or fruit-bearing bushes or vines; though there are several that infest forest trees—each species generally confining itself to a particular genus of trees. But in Europe there is a species, the Pear-tree Leaf-bug (*Tingis pyri*) which is so injurious to the Pear, that the French gardeners have given it the name of "the Tiger." It is to be hoped that it may never, like another European pest of pear-growers, the Pear-tree Flea-louse (*Psylla pyri*)—which has already been introduced into the New England States, and will perhaps make its way out West—traverse the Atlantic ocean and take out its naturalization papers in this country.

THE FLEA-LIKE NEGRO-BUG.—Third among the bogus Chinch Bugs may be mentioned the Flea-like Negro-bug (*Corimelæna pulicaria*,

[Fig. 9.]

Germar), of which I here present a magnified outline (Fig. 9). Its color is black with a white stripe each side. This insect resembles the Chinch Bug in having an ordinary 4-jointed beak, but differs from it in belonging to a very distinct and well marked group (*Scutellera* family), which is characterized by the enormous size of the "scutel" or shield.

In the most numerously represented division of this family the scutel forms a large triangle, extending along the back about half-way to the tip of the abdomen, as may be seen in the figure of the Spined Soldier-bug (Fig. 7), referred to on a previous page. But in another division of this family which does not contain nearly so many species, the scutel, instead of being angular, is rounded at top and covers more or less the entire upper surface of the abdomen. It is to this last division that the Flea-like Negro-bug belongs, and the dirty yellow or white stripes at its sides are really nothing but the thickened anterior edge of the front wings, all the remaining part of the front wings, as well as the entire hind wings, being, in repose, completely hidden under this enormously extended shield. In the Bordered Soldier-bug, as the reader will perceive from the annexed drawing (Fig. 10), which I reproduce from my First Report, the scutel is indeed rounded, and also extends a considerable distance over the abdomen; but as it otherwise agrees with the other Soldier-bugs in the rest of its organization, it is classified with them, and not with our Negro-bug.

[Fig. 10.]

The Flea-like Negro-bug has been known to injure various plants for two or three years back. I found it exceedingly abundant last summer in all parts of the State which I visited. It has a great passion for the fruit of the Raspberry, and is sometimes so plentiful as to render the berries perfectly unsaleable by the bed-bug aroma which it communicates to them, as well as by sucking out their juices. Wherever it occurs, the nauseous flavor which it imparts to every berry which it touches, will soon make its presence manifest, though the little scamp may elude ocular detection. It is really too bad that such a little black varmint should so mar the exceeding pleasure which a lover of this delicious fruit always experiences when in the midst of a raspberry plantation in the fruit season. It is also quite injurious to the Strawberry, puncturing the stem with its little beak, and thus causing either blossom or fruit to wilt; and the following extract, taken from a communication to the *Western Rural* by Mr. B. Pullen, of Centralia, Ills., undoubtedly refers to the same Bug, and would indicate that it made its first appearance in that neighborhood last summer:

"A new insect, to us here, has appeared on our strawberries for the first time the past season, damaging the crop very much. It resembles somewhat the Chinch Bug, so destructive to our wheat and corn, and, judging from the peculiar odor they emit on being mashed, should think them very nearly related. Some claim that they are of a different species altogether. Whether this be so or not those interested in the cultivation of the strawberry are anxiously looking forward to another season to see if they are to continue their depredations."

It likewise attacks the Strawberry in Canada, as an account of its attacking that plant, is given by my friend, C. J. S. Bethune, in the

Canada Farmer for August 1st, 1867; and it was under this very same serious charge that it was apprehended and brought up for trial at the last May meeting of the Alton (Ills.) Horticultural Society. It also attacks both Cherry and Quince, occurring on these trees in very large numbers, and puncturing the blossoms and leaves, but especially the fruit stems, which in consequence shrivel and die. It is also quite injurious to garden flowers and especially to the Coreopsis, and abounds on certain weeds, among which may be mentioned the Red-root or New Jersey Tea-plant (*Ceanothus Americanus*), and Neckweed or Purslane-speedwell (*Veronica peregrina*). In the month of June under these two last named plants, they may be found in countless numbers of all sizes and ages, from the small light brown wingless, newly hatched individuals, to the full fledged jet black ones. In fact they breed on these weeds, and there is no more effectual method of checking their increase and thus preventing their injuries to our cultivated fruits, than by sprinkling these weeds, and the ground underneath them, with a good strong solution of Cresylic soap. I should advise the propagation of a small patch of either one of these weeds near a strawberry patch, as a decoy for the Bugs, which may thus be, to some extent, enticed away from the strawberry plants, and killed more readily.

There are two other species of Negro-bug which are common in this State, though they never swarm in such injurious profusion as does the Flea-like Negro-bug. The first of these (*Corimelæna lateralis*, Fabr.) is absolutely undistinguishable from it however, except in being fully one-half longer and wider. The shape, sculpturing and coloring are exactly the same, even down to the lateral white stripe; so that, but for the fact of no intermediate grades in size occurring, the two would be certainly considered as mere varieties of one and the same species. The other Negro-bug (*Cor. unicolor*, Beauv.) is fully twice as long and wide as our insect; but though resembling it closely in every other respect, yet differs very notably in lacking the white anterior edging to the front wings. It might indeed be said, that the biggest Negro dresses entirely in black, while the two other smaller sized darkies relieve the sombre monotony of their sable suits, by wearing a conspicuously white shirt-collar.

To these three bogus Chinch Bugs, might be added one or two other species of small stinking Bugs which have been, by some persons, mistaken for the true Chinch Bug. But enough has been already said to show, that insects which in reality are shaped and fashioned as differently as are cows and deer, are yet often confounded together in the popular eye, principally, no doubt, because they have the same peculiar bed-bug aroma. Should the ignorance of the popular judgment in confounding these tiny creatures which seem to the Entomologist so very, very different from each other, therefore, be despised and ridiculed? Far be it from me to display such intolerant stupidity! As well might the nurseryman ridicule the grain grower, because the grain-grower cannot distinguish a Baldwin Seedling from a High top apple; or the grain-grower the nurseryman because the nurseryman cannot tell Mediterranean from Tea wheat, or Club from Fife. I do, however, entertain an abiding hope that by the present very general and praiseworthy movement towards the popularization of Natural History, and by the dissemination of Entomological Reports, a better knowledge of this practically important subject will soon exist in the community. Our farmers will then, not so often wage a war of extermination against their best friends, the cannibal and parasitic insects, while they overlook and neglect the very plant-feeders which are doing all the damage, and upon which the others are feeding in the very manner in which a Wise Providence has appointed them to adopt.

RECAPITULATION.

The following important points in the history of the Chinch Bug, may be considered as firmly established:

1st. Chinch Bugs hybernate in the perfect or winged state in any old dry rubbish, under dead leaves, in old straw, in corn-shucks and corn-stalks, among weeds in fence-corners, etc., etc. Therefore all such substances should be burned up,as far as possible, inthe spring.

2nd. The earlier small grain can be sowed in the spring, the more likely it is to escape the Chinch Bug; for it will then get ripe before the spring brood of bugs has had time to become fully developed at the expense of the grain.

3d. The harder the ground is where the grain is sowed, the less chance there is for the Chinch Bug to penetrate to the roots of the grain and lay its eggs thereon. Hence the importance of fall-ploughing and using the roller upon land that is loose and friable. And hence, if old corn-ground is sufficiently clean, it is a good plan to harrow in a crop of small grain upon it without ploughing it at all. Moreover this rolling plan should always be adopted, as the best wheat-growers both in this country and in Europe attest that the heavier the ground for wheat is rolled, the better will be the crop.

4th. A single heavy rain immediately checks up the propagation of the Chinch Bugs. Continued heavy rains diminish their numbers most materially. A long-continued wet season, such as that of 1865, almost sweeps the whole brood of them from off the face of the earth; but from the rapid rate at which they multiply there will always be enough left for seed for another year. It may be laid down, not only as a general, but universal rule, that this insect is never ruinously destructive, except in those sections of country where there is continued hot dry weather; and that if, in two adjoining districts, there has been a dry summer in one and much wet weather during the summer season in the other, however plentiful and destructive the bug may be in the first district, it will scarcely be heard of in the second. Certainly this state of facts is not exactly that from which any reasonable man would infer, that the paucity of Chinch Bugs in a wet season is caused by an Epidemic Disease taking them off. We might as well maintain that, although there was no Epidemic Disease among the children of Israel that had just crossed the Red Sea, or among the Egyptians that staid at home, it was simply and solely an Epidemic Disease that slew the pursuing hosts of the Egyptians and covered the bottom of the Red Sea with their carcasses.

THE ARMY-WORM—*Leucania unipuncta*, Haw.

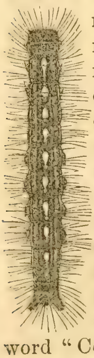
[Lepidoptera Noctuidæ.]

Among those insects which attract especial attention, either from the peculiarity of their habits, or the vast amount of damage which they inflict, the notorious Army-worm holds a conspicuous place. The mode in which these worms travel in vast armies when in search of food, the great value of the cereals and the grasses to which they for the most part confine their ravages, their sudden appearance in such incomputable numbers, and their equally sudden disappearance, all tend to arouse the curiosity and interest of even the most indifferent observer.

Before giving a history of this insect, it will be necessary to state that there are four distinct caterpillars, producing four perfectly distinct moths, which have been designated as Army-worms in various parts of the United States.

First—The Tent-caterpillar of the Forest (*Clisiocampa sylvatica*, Harr.) has been erroneously known by the name of "Army-worm" in the northwest corner of the State of New York. A back view of this caterpillar is given in the accompanying sketch (Fig. 11) by which it will at once be recognized by the reader. For a number of days, last June, this worm might have been seen marching "single file" up the railroad track on Pilot Knob, in the scorching rays of the noonday sun; and it is often found crawling along roads in very considerable numbers. Yet it cannot with propriety be called an Army-worm, and our Eastern friends had best drop the title and avoid confusion in the future.

[Fig. 11.]



Second—The Cotton-worm (*Anomis xylina*, Say), is very generally known by the name of "the Cotton Army-worm," in the South. The term as applied to this species is not altogether inappropriate, as the worm frequently appears in immense armies, and when moved by necessity will travel over the ground in "solid phalanx;" and so long as the word "Cotton" is attached—its ravages being strictly confined to this plant—there is no danger of its being confounded with the true Army-worm. The term has furthermore received the sanction of custom in the Southern States, and of Mr. Glover in his Department Reports.

As various attempts have been made, with more or less success, to grow the cotton plant in the southern parts of this State, a description of this insect will not be inappropriate, the more especially, since it will teach the reader the difference between it and the true Army-worm.

The Cotton-worm was first scientifically described by Mr. Thomas Say, in the year 1827. According to Dr. D. L. Phares, of Woodville, Miss., it destroyed at a low estimate, 200 tons of cotton in the Bahamas as long ago as 1788; while in Georgia it completely destroyed the crop in 1793. According to Dr. Capers* its injuries were noticed in 1800, and it likewise proved very destructive in 1804, 1825 and 1826. Since the last date, as we may learn from old volumes of the *American Farmer*, of Baltimore, Md., and from the Patent Office Reports, it has done more or less damage to the crop almost annually, in some part or other of the cotton-growing district. As with the real grass-feeding Army-worm of the Middle States, it swarms in particular years to such an extent as to utterly ruin the crop, while in other years it is scarcely noticed. This fact has led many to infer that there is a stated periodicity in its returns in such immense numbers; but the natural history of the worm confutes such an idea, while the records give no foundation for the inference. The sudden increase or decrease of this, as of other species of noxious insects, depends on climatic, as well as on other equally potent influences.

[Fig. 12.]

The egg, (Fig. 12, *a*), according to Dr. Phares is shaped "precisely like a scull-cap, with rows of pinheads from base to apex as thickly set as possible," appearing as if moulded in a very deep saucer. These eggs are of a translucent green color, and are deposited upon the under side of the leaves, and from their small size, are naturally difficult of detection. Each female moth deposits from 400 to 600, and according to the late Thomas Affleck, of Brenham, Texas, they hatch two days after being deposited, if the weather be moist and warm. The worms (Fig. 12 *b*, $\frac{1}{3}$ grown) at first feed upon the parenchyma or soft fleshy parts of the leaves, but afterwards devour in-

*Patent Office Rep., 1855, p. 74.

differently, not only any portion of the leaves, but also the blossom-bud and blossom, together with the calyx leaves at the base of the boll, thus causing the lobes which hold the cotton, to fall entirely back and allow the cotton to drop at the slightest touch. While young these worms readily let themselves down by a web when disturbed, but when older they make less use of this web, and jerk themselves away to a considerable distance when suddenly touched. They cast their skins at five successive periods, and come to their growth in the incredibly short space of fifteen or twenty days. Mr. Affleck even states that they usually enter the chrysalis state on the eleventh day after hatching; but I incline to believe that such a brief larval existence is extremely exceptional, and the length of time required for them to mature will not only differ in different individuals of the same brood, but will vary with the state of the atmosphere. At Figure 12 *c* is given a side view, and at *d* a back view of a full-grown worm. It has the normal complement of legs—namely 16—but the two foremost pair of false legs, or those under segments 6 and 7, are so reduced in size that they are scarcely used in motion, and it consequently loops when walking.

I have upon two occasions received full-grown specimens of this worm, and they differ materially, both in depth of shade, coloration and markings, as indeed do almost all the larvæ of moths belonging to the same (*Noctua*) family. The most common color is light green, though they are frequently quite dark with a purplish hue at the sides, and with black backs. Whether light or dark colored, however, they are more or less distinctly marked with pale longitudinal lines and black spots, as in the above figures.

Mr. Lyman, in his "Cotton Culture," says of this insect: "The first moths that visit a crop deposit their eggs and die. These eggs in ten days become little worms, which fall to eating the leaf on which they were hatched, and as they grow, consume the plant and pass to another. But age comes on apace with these ephemeral creatures; the worm presently grows weary of devouring, selects a leaf, rolls himself in a little cocoon and *dies*." Of course this is a serious mistake to think that the worm dies, else how could it produce the moth which, as Mr. Lyman himself shows, afterwards issues from the cocoon. It is astonishing to find such gross errors creeping into our popular works, but then, the study of these contemptible little Bugs, even if they do sometimes totally destroy the crop, is of course beneath the dignity of the man who can write a work on cotton culture!! The truth of the matter is that, when they have completed their growth, the worms fold over the edge of a leaf (Fig. 12 *e*), and, after lining the inside with silk, change to chrysalids (Fig. 12 *f*), which are at first green, but soon acquire a chestnut-brown color; after remaining in this last state (in which, though the insect is inactive, it is yet full of life, and undergoing wonderful development) from seven to fourteen days, or even longer, the moth escapes, the chrysalis being held fast within the cocoon by means of several very minute hooks with which the tail is furnished.

[Fig. 13.]

At Figure 13 *a*, this moth is represented with the wings expanded, and at *b*, with the wings closed. The general color of the upper surface is a golden-yellow inclining to buff, with a faint olive tint near the outer or posterior margin. The fore wings are crossed, as in the above figures, by more or less distinct, irregular lilac-colored lines. But the chief characteristic is a dark slate-colored, or black spot on the front wings, in which spot there are paler scales forming almost a double pupil as represented in the figures, while between this spot and the base of the wings there is a much smaller pure white dot. In general color and in the position of the larger spot, this moth bears a remarkable resemblance to that of the true Army-worm of the Northern and Middle States.

Mr. Affleck, who certainly had abundant opportunities for observing the fact, assured me that this moth rests in the position shown in Figure 13, *b*, namely, with the head downwards. He wrote on August 22d, 1868: "The Cotton moth (*Ophinsa xylina* of Harris in his correspondence with myself) never alights in any other position, or if by accident it first assumes another position, it instantly wheels around *head down*."

According to the best authority, there are three different broods of worms during the year, the first appearing in June or July, and the last, which does the most damage, appearing in August or September, or even later. Mr. Lyman, in the little work already referred to, says: "That nature has made no provision by which either the fly, the worm, the chrysalis or the eggs, can survive the winter or exist for any length of time where the cotton plant is not a perennial." But this is surely an error, which Mr. Lyman would never have made, had he possessed a better knowledge of insect-life; and as Mr. Glover found that the chrysalis was killed by the slightest frost, the insect evidently winters over in the moth state, as do many others belonging to the same tribe. Mr. W. B. Seabrook gives strong evidence that this is the case, in a "Memoir on the Cotton Plant," read in 1843, before the State Agricultural Society of South Carolina, wherein he says: "That the Cotton Moth survives the winter is nearly certain. An examination of the neighboring woods, especially after a mild winter, has often been successfully made for that purpose." And Dr. Phares states positively that the moth hybernates in piles of cotton seed under shelter, under bark and in crevices of trees in dense forests and other secluded places, and that it may often be seen on pleasant days in winter.

The two principal remedies which have hitherto been relied upon are, 1st, hand-picking; 2d, destroying the moths by fires, to which they are naturally attracted. The first method is sure, but tedious and somewhat impracticable on a very large scale. The second is most effectual if carried out when the first moths appear, in May and June. If these two methods were persistently carried out in the early part of the season throughout any given cotton-growing county, they would of themselves be sufficient to save the crop; but the efforts of individuals are of no avail, where there are slovenly neighbors who neglect to perform these labors. It would therefore be of incalculable advantage, if something could be applied to the plants which would prevent the moths from depositing their eggs upon them, as the industrious planter could then set at defiance his more slovenly neighbor. Mr. Affleck was enthusiastic in his praise of cresylic soap as such a plant-protector, and I received a long letter, written a few weeks previous to his death, and showing how he had found that no cotton moth had ever deposited an egg on any plant that had been sprinkled with a solution of this soap. But Dr. Phares states that it was pretty thoroughly tried last year, and proved a failure, though he does not give the reason why.

It is some little consolation to know that the character of the season determines their numbers, and that if none make their appearance in any stage by the first of July, there is little to be feared from them the rest of that year.

Third—There is in the South another insect (*Laphrygma frugiperda*, Sm. & Abb.?) which is frequently known by the ominous name of "Army worm;" an insect which also will attack cotton, though it prefers grasses and weeds. This species in its habits resembles the true Army-worm of the Middle States, more closely perhaps than does the Cotton Army-worm, and Mr. Joseph B. Lyman, in his recent work on "Cotton culture"* (p. 92), calls it *the* "Army-worm;" yet to prevent confusion, the cognomen should be discontinued, and the term "Southern Grass-worm" (by which it is already very generally known) should be strictly applied to this third bogus Army-worm. We now come to the veritable Army-worm of the Northern and Middle States —the insect which is the subject of this article, and we will dwell for a few moments on the

PAST HISTORY OF THE TRUE ARMY-WORM.

If we trace back the history of the Army-worm in this country, we find that inaccuracy and confusion characterize most of the records concerning it previous to the year 1861. In that year, however, by the contemporaneous observations and experiments of several entomologists, in different sections of the United States, its natural history was first made known to the world, and the parent moth identified.

* Cotton Culture, by J. B. Lyman, late of Louisiana. Orange Judd & Co., New York.

The very earliest record which we find of its appearance in this country is in Flint's 2nd Report on the Agriculture of Massachusetts, where it is stated that in 1743 "there were millions of devouring worms in armies, threatening to cut off every green thing."

In 1770 it spread over New England in alarming numbers. Dr. Fitch in his 6th Report quotes the following full and interesting account from the Rev. Grant Powers's Historical Sketches of the Coös Country in the Northern part of New Hampshire. "In the summer of 1770 an army of worms extended from Lancaster, the shire town of Coös County, N. H,, to Northfield, Mass., almost the whole length of the Granite State. They began to appear the latter part of July, and continued their ravages until September. They were then called the 'Northern Army,' as they seemed to advance from the north or northwest to the south. It was not known that they passed the highlands between the rivers Connecticut and Merrimack. Dr. Burton, of Thetford, Vermont, informed the author that he had seen the pastures so covered with them, that he could not put down his finger without touching a worm, remarking that 'he had seen more than ten bushels in a heap.' They were unlike anything that generation had ever seen. There was a stripe upon the back like black velvet, and on each side a stripe of yellow from end to end, and the rest of the body was brown. They were seen not larger than a pin, but in maturity were as long as a man's finger and of proportionate thickness. They appeared to be in great haste, except when they halted to feed. They entered the houses of the people and came up into the kneading troughs as did the frogs in Egypt. They went up the sides of the houses and over them in such compact columns that nothing of the boards or shingles could be seen. Pumpkin-vines, peas, potatoes and flax escaped their ravages. But wheat and corn disappeared before them as by magic. Fields of corn in the Haverhill and Newbury meadows, so thick that a man could hardly be seen a rod distant, were in ten days entirely defoliated by the 'Northern Army.' Trenches were dug around fields a foot deep, as a defence, but they were soon filled and the millions in the rear passed on and took possession of the interdicted feed. Another expedient was resorted to: Trenches were cut, and thin sticks, six inches in diameter, were sharpened and used to make holes in the bottom of the trenches within two or three feet of one another, to the depth of two or three feet in the bottom lands, and when these holes were filled with worms, the stick was plunged into the holes, thus destroying the vermin. In this way some corn was saved. About the first of September the worms suddenly disappeared. Where or how they terminated their career is unknown, for not the carcass of a worm was seen. Had it not been for pumpkins, which were exceedingly abundant, and potatoes, the people would have greatly suffered for food. As it was, great privation was felt on account of the loss of grass and grain."

The same writer adds that "in 1781, eleven years after, the same kind of worm appeared again, and the fears of the people were greatly excited, but this time they were few in number."

In 1790 their ravages are again recorded in Connecticut, where they were very destructive to the grass and corn, but their existence was short, all dying in a few weeks (Webster on Pestilence, I, 272.)

Their next appearance in the Eastern States was in 1817, after an interval of twenty-seven years, according to Fitch, who quotes the following paragraph from the Albany (N. Y.) *Argus:*

Worcester, *Mass.*, *May* 22*nd*, 1817.—"We learn that the black worm is making great ravages on some farms in this town, and in many other places in this part of the country. Their march is a 'displayed column,' and their progress is as distinctly marked as the course of a fire which has overrun the herbage in a dry pasture. Not a blade of grass is left standing in their rear. From the appearance of the worm it is supposed to be the same which usually infests gardens, and is commonly called the *cut worm*. * * * This same worm is also destroying the vegetation in the northern towns of Rensselaer and eastern section of Saratoga, New York. Many meadows and pastures have been rendered by their depredations as barren as a heath. It appears to be the same species of worm that has created so much alarm in Worcester county, but we suspect it is different from the cut worm, whose ravages appear to be confined to corn."

It was not until after a lapse of forty-four years from the last mentioned date, namely, in the summer of 1861, that this worm again spread over the meadows and grain fields of the Eastern States. During the interval, however, it had from time to time attracted attention in the Western States, where it often proved quite destructive. Thus, in Illinois, it is recorded as having appeared in 1818, 1820, 1825, 1826, 1834, 1841, 1842, 1845 and 1856, and according to Mr. B. F. Wiley, of Makanda, Ill., it was quite numerous and destructive in the southern part of the State in 1849, and appeared there also in 1857, though it was confined that year to limited localities.* Mr. J. Kirkpatrick, of Ohio, mentions its appearance in the northern part of that State in 1855. He says: "Last season (1855), in consequence of the heavy rains in the early part of June, the flats of the Cuyahoga, near Cleveland, were flooded. After the subsidence of the water, and while the grass was yet coated with the muddy deposit, myriads of small blackish caterpillars appeared; almost every blade had its inhabitant; no animal could feed upon it without, at every bite, swallowing several; if a new blade sprung up, it was immediately devoured, but what was most remarkable, the insects did not attempt to remove to land a foot or two higher but that had not been covered by the water."†

**Prairie Farmer,* July 18th, 1861.

†Ohio Agricultural Report, 1855, p. 350.

The year 1861 will long be remembered as a remarkable Army-worm year, for this insect was observed in particular localities throughout the whole northern and middle portion of the United States from New England to Kansas. It was first noticed in numbers sufficient to cause alarm, in Tennessee and Kentucky during the month of April; and toward the close of the same month it appeared in the southern counties of Illinois. By the end of June it had visited nearly all portions of the latter State, proving more or less destructive to grass, wheat, oats, rye, sorghum and corn.

Its advent in Missouri was simultaneous with that in Illinois, and judging from what facts I have accumulated, it occurred very generally over this State, though recorded only in St. Louis, Jefferson, Warren, Boone, Howard and Pike counties. No mention is made of its occurrence, at this time, in any of the States or Territories west of Missouri, but to the East, scarcely a single State escaped its ravages. In many portions of Ohio it entirely destroyed the hay and grain crops, and in the eastern part of Massachusetts the damage done was reported to exceed a half million of dollars.

Singularly enough, I can find no trace of the occurrence of this insect in Missouri prior to the year 1861, and the first intelligible account of it from the pen of a Missourian, is that by Dr. Wislizenus of St. Louis, published in the Transactions of the St. Louis Academy of Science (Vol. II, No. 1, pp. 159–60). My good friend Wislizenus then erroneously supposed it to be identical with the *Bombyx graminis* of Northern Europe—an insect which commits similar devastations on the grasses and cereals in that country. But I believe he is now well aware that it is an entirely distinct species.

Since 1861 the Army-worm has never spread so generally over such a vast extent of country, though in 1865 it appeared in considerable numbers around St. Joseph in this State, and in 1866 did some damage near Quincy, Ills., as we learn from the Quincy *Whig*.

Last year it made its appearance again in vast numbers in many portions of this State, especially in St. Louis, Jefferson, Cooper, Callaway, Henry, St. Clair, Marion, Ralls, and Lafayette counties, and in some counties in Illinois and Indiana. The first intimation I received of its appearance in Missouri was the following letter sent to me by Mr. A. E. Trabue of Hannibal, under date of June 8th:

I inclose a match-box with grass and two worms, which we think are Army-worms. They are here in myriads destroying the grass. Destroyed a hundred acres of blue grass meadow in five days, and are now advancing on me. What are they and their habits?

Carbolic acid (one part acid, 20 parts water) kills them if they get a good drench with it, but is too expensive at that rate. They will cross a trail of it without injury, though they evidently dislike the smell. Have sent to town for coal tar to see if they will cross it when the ground is soaked with it. The advancing column is a half mile wide.

The hogs are very fond of them; will not notice corn when they can get Army-worms, but we have more of the latter than they can dispose of.

A. E. TRABUE.

Upon receipt of this letter, I visited Hannibal and ascertained that the worm was even more numerous around New London, and especially on the farm of Mr. A. McPike.

ITS SUDDEN APPEARANCE AND DISAPPEARANCE.

The popular idea about the sudden appearance of an insect has always been an erroneous one. The "blows" or "gentiles" in meat, "skippers" and mites in cheese, plant-lice on plants, etc., etc., are very generally supposed to have a spontaneous origin, and our sudden Army-worm invasions have very generally been accounted for in the same way, by those who know nothing of Nature's workings. Yes, and so-called *savans*—will it be credited !—have been anxious to so far tickle the popular fancy as to conceive and give birth to theories (such as that of larval reproduction) which were not one whit more sensible or tenable.

It is well known to entomologists, and the reader, by perusing the article on "Cut-worms" in my First Report, will soon become aware of the fact, that most of the larvæ of our Owlet Moths (family *Noctuidæ*) rest hidden during the day and feed in the morning and evening, or at night. They are all smooth, tender-skinned worms, and cannot endure the scorching rays of the sun. Consequently many of them live almost habitually, just under the surface of the soil, while others shelter themselves under vegetable substances during the day. Our Army-worm forms no exception to the rule, for upon closely watching the habits of the hosts I witnessed last summer in the field, and of hundreds which I had confined in breeding cages, I ascertained that they frequently hide themselves Cut-worm fashion, just under the surface of the ground, or under the plants upon which they feed. The Army-worm delights, in fact, in cool, moist and shady situations, and from the passage already quoted, from Mr. Kirkpatrick, where it is shown that the worms which swarmed on the Cuyahogo flats, did not attempt to remove to land a foot or so higher: and from further facts recorded by Dr. Fitch, it becomes evident that its natural abode is in the wild grass of our swamps, or on low lands. During an excessive dry summer these swampy places dry out, and the insect, having a wider range where the conditions for its successful development are favorable, becomes greatly multiplied. The eggs are consequently deposited over a greater area of territory, and if the succeeding year prove wet and favorable to the growth of the worms we shall have the abnormal condition of their appearing on our higher and drier lands, and of their marching from one field to another. For just so soon as the green grass is devoured, in any particular field in which they may have hatched, these worms are forced, both from hunger and from their sensibility to the sun's rays, to leave the denuded field.

Thus the fact becomes at once significant and explicable, that almost all great Army-worm years have been unusually wet, with the preceding year unusually dry, as Dr. Fitch has proved by record. The appearance of this insect last summer in the West forms no exception, for the summer of 1868 was unusually dry and hot, while that of 1869 was decidedly wet. I may remark here, in further corroboration of these views, that, as might have been expected, no Army-worms were noticed last year in the Eastern States; for though in the summer of 1868 we of the West suffered so severely from drouth, yet in the East they were blessed with the usual amount of rain-fall, and in some sections had even more than the average amount.

There is in reality nothing in the least mysterious in the sudden appearance and disappearance of the Army-worm, for the truth of the matter is, that there are a few of these insects in some part or other of the country every year, and I have for the past four or five years captured one or more specimens of the moth every fall. The eggs hatch during the early part of May, in the latitude of South Illinois and South Missouri, and the young worms may feed by millions in a meadow without attracting attention; but when they have become nearly full grown and have stripped bare the fields in which they were born, and commence to march as described above, they necessarily attract attention, for they are then exceedingly voracious, devouring more during the last three or four days of their worm-life, than they had done during the whole of their previous existence. As soon as they are full grown they burrow into the earth, and, of course, are never seen again as worms.

Their increase and decrease is dependent on even more potent influences than those of a climatic nature. The worms are attacked by at least eight different parasites, and when we understand how persistent these last are, and how thoroughly they accomplish their murderous work, we cease to wonder at the almost total annihilation of the Army-worm the year following its appearance in such hosts. In the words of the late J. Kirkpatrick "their undue increase but combines the assaults of their enemies and thus brings them within bounds again."

We must also bear in mind, that besides these parasitic insects, there are some cannibal insects, such as the Fiery Ground-beetle (*Calosoma calidum*, Fabr.) and its larva,* which prey unmercifully upon the worms, while the "Mosquito Hawks" (*Libellulæ*) and bats, doubtless destroy many of the moths. Hogs, chickens and turkeys revel in the juicy carcasses of the worms, and sometimes to such an extent that, as I am informed by Mr. T. R. Allen, of Allenton, the former occasionally die in consequence, and the latter have been known to lay eggs in which the parts naturally white, would be green when cooked. Small birds, of various kinds, and toads and frogs also,

*First Report, Fig. 34.

come in for their share of this dainty food; while the worms, when hard pushed, will even devour each other.

NATURAL HISTORY OF THE ARMY-WORM.

Previous to the year 1861, but very little accurate knowledge had been acquired respecting the habits of the Army-worm, and nothing whatever of a scientific nature had been published.

A few very observing farmers ventured to predict its appearance during very wet summers succeeding very dry ones. They did not know why this was the case, but it was a fact that they had learned from experience. It was also known that the worm attacked only the grasses and cereals, that it was gregarious in its habits, and that it disappeared suddenly, in a manner as seemingly mysterious as that in which its advent was supposed to have been made.

These few facts were about the only ones of real value, respecting the habits of this insect, that could be gleaned from the statements of those who had suffered most from its ravages; while the subject seems to have been, up to that time, entirely ignored by entomological writers.

In 1861, however, its very general appearance, and the vast amount of damage it did, attracted the attention, not only of farmers, but of several well-known entomologists, among whom may be mentioned our late friends, Walsh, of Illinois, and Kirkpatrick, of Ohio; and Cyrus Thomas, of Illinois, Dr. Fitch, of New York, and J. H. Klippart, of Ohio.

As might have been expected, diverse conclusions were arrived at, and various theories entertained by these writers, and some very spirited correspondence between Messrs. Walsh and Thomas and Walsh and Klippart may be found in old files of both the *Ohio Farmer* and the *Prairie Farmer*.

The principal point of dispute was, whether the Army-worm wintered in the egg or chrysalis state, and, as a consequence, whether it was single or double-brooded.

It is needless to follow these gentlemen in their discussions, which were frequently caustic and pungent; but sometimes partook more of the character of personal wrangling than of a calm and conscientious search after truth. Two of the five parties mentioned above, are now in their graves, and while one of those yet living—Mr. Cyrus Thomas—believed in the two-brooded character of the insect; the other two evade the question entirely. Mr. Walsh took the ground that it was single-brooded, and the experience of the past year has convinced me that he was correct.

The Army-worm, like all other insects, hatches from an egg, and this egg is evidently deposited by the parent moth at the base of perennial grass-stalks. In Southern Missouri it hatches out about the middle of April; in the central part of the State about the first, and in the northern part about the middle of May; in Massachusetts, about the middle of June, and in Maine about the middle of July. In every locality the worm goes underground about a month afterwards to assume the pupa or chrysalis state, and stays underground between two and three weeks. Hence, in the southern part of this State the moth appears about the fore part of June, and a month later in each successive locality as we go north, till in Maine, the period becomes the fore part of September. Of course, these dates will vary somewhat with the character of the seasons, and sometimes from local causes; but, broadly speaking, they will hold good.

The moths soon pair, and sometime during the summer and fall months, deposit their eggs in the positions already indicated. Many eggs are thus deposited in tame meadows, but there is little doubt in my mind that the great bulk of these eggs are deposited in low, damp situations, and if the fall should prove wet, instead of dry, many of them would perhaps get drowned out, and we should thus have another potent influence at work to decrease the numbers of the worm the succeeding year. I make this suggestion with all due consideration, for I have long since concluded that the instincts of insects, as of some of the higher animals, are not always sufficient to guard against all contingencies. It has been demonstrated beyond the possibility of a doubt, that the Plum Curculio deposits its eggs in fruit that overhangs water, and in other positions where the grub must inevitably perish; and certain flesh-flies are well known to deposit their eggs, by mistake, on flowers which have a putrescent smell. Darwin has remarked that a small South American bird (*Furnarius cunicularius*) which builds its nest at the bottom of a narrow, cylindrical hole, which extends horizontally several feet underground, is so incapable of acquiring any notion of thickness, that, although he saw specimens constantly flitting over a low clay wall, they continued vainly to bore through it, thinking it an excellent bank for their nests.* Many such instances of misdirected instinct might be cited, and they all lead me to believe that the female Army-worm moth would be just as likely to lay her eggs in situations where they would drown out, as in situations more favorable.

The above may be considered as the normal habit of the Army-worm; but exceptional individuals occur, perhaps one in a hundred, but demonstrably not as many as one in twenty, which lie in the chrysalis state all through the winter and do not come out in the moth state till the following spring. The proportion of those which lie over till spring is doubtless greater in the more northern States than it is with us. The great fault which Mr. Walsh made in his excellent paper on this insect, published in the Illinois State Agricultural Transactions for 1861, was, that he drew his lines too rigidly, and allowed of no exceptions to the rule which he laid down, of its single-broodedness. He also fell into an error in roughly estimating

*Voyage Round the World, p. 95.

the average life of the moth at from three to five weeks. I have often caught the moths, both in the fall and spring months, even in years when the worms themselves were unnoticed by farmers; and Dr. Levi Bartlett, formerly of Pesotum, Ills., informed me while he was practising in Chicago, that he had himself ascertained that they would sometimes live at least three months, and that he had often found them as late as October. We must also bear in mind that they do not all mature and issue from the ground together, even in the same locality; but that an interval of from six to eight weeks may intervene between the issuing of the first and last moths. With these facts before us it is easy to comprehend how some of the moths live long enough to deposit their eggs on newly sown fall grain, though grass meadows are more favorite resorts. It also becomes clear that the moths may sometimes lay their eggs before harvest upon growing grain, sufficiently high from the ground, for the egg to be carried off with the straw; and this accounts for several well authenticated instances of the Army-worm starting from stack-yards.

The Army-worm larva varies but little in appearance from the time it hatches to the time when it is full grown. Some specimens are a shade darker than others, but on many thousands examined, I have found the markings very uniform as represented in the annexed

[Fig. 14.]

cut (Fig. 14). The general color is dingy black, and it is striped longitudinally as follows: On the back a broad dusky stripe; then a narrow black line; then a narrow white line; then a yellowish stripe; then a narrow sub-obsolete white line; then a dusky stripe; then a narrow white line; then a yellowish stripe; then a sub-obsolete white line; belly obscure green. Those who are more particular will find a detailed description at the end of this article.

The chrysalis (Fig. 15) is of a shiny mahogany-brown color, with two stiff converging thorns at the extremity, having two fine curled hooks each side of them. The

[Fig. 15.]

general color of the moth is light reddish-brown or fawn color, and it is principally characterized by, and receives its name from, a white spot near the center of its front wings, there being also a dusky oblique line running inwardly from their tips. The accompanying

[Fig. 16.]

illustration (Fig. 16), though darker than it should be, will show wherein it differs from the Southern Cotton Army-worm, notwithstanding the colors of the two moths are nearly alike. Our Army-worm moth was first described by the English Entomologist Haworth in the year 1810, in his *Lepidoptera Brittanica*, page 174, as *Noctua unipuncta*. Subsequently the French Entomologist Guenée

(*Noctuelites* I, p. 77) overlooking the former's description, and regarding it as a new species, named it *Leucania extranea.* Of course Haworth's name takes the precedence. It is considered a common species even in European collections, and Guenée mentions it as occurring in Brazil. A variety without the white spot occurs in Java and India, and still another, lacking the white spot, and having a dark border on the hind wings, occurs in Australia; while an occasional specimen has been captured in England. A figure is given in Stainton's Entomologist's Annual for 1860, of one captured there in 1859, but if the figure be a correct one, the specimen is much lighter than ours, and the characteristic white spot is not nearly so conspicuous.

PARASITES OF THE ARMY-WORM.

THE RED-TAILED TACHINA FLY—*Exorista leucaniæ*, Kirk.—To one who has never before seen the Army-worm in its might, the sight of the myriads as they return thwarted in their endeavors to cross, or of the living, moving and twisting mass which sometimes fills a ditch to the depth of several inches; is truly interesting. At Hannibal I was much surprised to find that fully nine worms out of every ten had upon the thoracic segments, just behind the head, from one to four minute, narrow, oval white eggs, about 0.04 inch long, attached firmly to the skin; and my companions were equally surprised when I informed them that these were the eggs of a parasite, and that every one of the worms which had such eggs attached to it, would eventually succumb to one of the maggots these eggs produced. The eggs are no doubt deposited by the mother fly just behind the head, so that the worm may not reach the young maggots when they hatch, and be enabled to destroy them with its jaws. I have found several different kinds of cut-worms with just such eggs attached invariably on the back just behind the head. They are glued so strongly to the skin of the worm that they cannot be removed without tearing the flesh.

The large two-winged parasitic flies which deposited these eggs, were wonderfully numerous, buzzing around us and about the worms like so many bees, and the moment one was caught, I recognized it as the Red-tailed Tachina Fly. This is one of the most common and abundant of the Army-worm parasites, and attacks it in widely different parts of the country. I have also bred the same fly from the Variegated cut-worm (larva of *Agrotis inermis**), and a variety of it from our common large Cecropia worm, which is often found on apple and other fruit trees. It was first very briefly and imperfectly described as *Exorista leuca*[*i*]*æ*, by the late J. Kirkpatrick, in the Ohio Agricultural Report for 1860, page 358, and was subsequently much more fully described as *Senometopia* [*Exorista*] *militaris* by Mr. Walsh, in his Army-worm paper already referred to. Of course Mr. Kirkpatrick's

*First Report, p. 72.

name has the priority, but I introduce Mr. Walsh's original description of the fly and likewise the very same figure (Fig. 17) which he used to illustrate it.

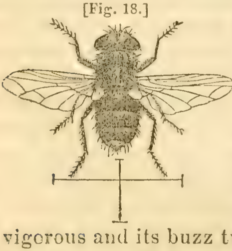
[Fig. 17.]

Exorista leucaniæ—Length, .25 to .40 inches, or from 6 to 10 millimetres, the females not exceeding .30 inch. Face silvery, with lateral black hairs only on the cheeks, at the top of which is a black bristle. Front, golden-olive, with a black central stripe, and lateral black convergent hairs. Occiput, dusky. Labium, brown, with yellowish hair. Maxipalps, rufous. Eyes, cinnamon-brown, covered with very short dense whitish hair. Antennæ, two basal joints, black, with black hairs; third joint, flattened, dusky, and from two and a half to three times the length of the second joint; seta, black. The entire hinder part of the head covered with dense whitish hair. Thorax glabrous, bluish-gray, lighter at the side, with four irregular black vittæ, and black hairs and bristles. Scutel, reddish-brown, whitish behind, glabrous, with black hairs and bristles. Pectus, black, glabrous, with hairs and lateral bristles. Legs, black, hairy; thighs, dark cinereous beneath; pulvilli, cinereous. Wings, hyaline; nervures, brownish; alulæ, opaque greenish-white. Abdomen, first joint black; second and third, opalescent in the middle with black and gray, and at the sides with rufous and gray; last joint, rufous, slightly opalescent at the base with gray; all with black hairs and lateral bristles. Beneath, the first joint is black, the others black, margined with rufous, all with black hairs. In the male the space between the eyes at the occiput is one-seventh of the transverse diameter of the head; in the female it is one-fourth. The colors of the abdomen sometimes "grease" and fade in the dried specimen.

Bred fifty-four specimens from about the same number of Army-worms. Described from eight males and six females. Two species, similarly marked with rufous, but generally distinct, occur at Rock Island.

Mr. Kirkpatrick also described on the same page of the Ohio Report for 1860, another species (?) to which he gave the name of *Osten Sackenii*. But upon the very face of it, this proves to be but a smaller specimen of his *leucaniæ;* for the characters on which he would build this other species, are none of them constant. He says it differs from *leucaniæ* in its smaller size; in the gray bands on the abdomen not being so distinct; in some little variation in the position of the brown, and in the *pulvill*[*i*]*æ* being more distinctly gray. Now *leucaniæ* varies from 0.25 to 0.40 inch in length; the brown on the abdomen is opalescent and varies; the pulvilli and gray abdominal markings vary far more in depth of shade than there set forth, and the abdomen in fact, if the least greasy, often loses all trace of gray.

[Fig. 18.]

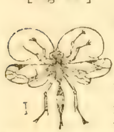


THE YELLOW-TAILED TACHINA FLY, (*Exorista flavicauda*, N. Sp.)—We have another species in Missouri however, which may be called the Yellow-tailed Tachina Fly, and which differs so notably from the Red-tailed species that it may be recognized even on the wing. It is almost twice as large, and the head instead of being narrower than the thorax as in *leucaniæ* is broader. Its flight is also more vigorous and its buzz twice as loud, I represent this species at Figure 18, and draw up the following description for the scientific reader:

Exorista flavicauda, N. Sp.—Length, 0.35 to 0.50 inch. *Head* broader than thorax; face, silvery-white, the cheeks inclining to yellow, with lateral black hairs extending to near the base of antennæ, and one stiffer and longer bristle at top of cheeks; front, dusky, ferruginous, with two rows of black converging bristles; divided by a broad depressed stripe of a brighter ferruginous color and without bristles; occiput bright ferruginous; labium ferruginous with hairs of same color; maxipalps rufous; eyes dark mahogony-brown, and *perfectly smooth;* antennæ, two basal joints rufous, with black hairs, third joint flattened, dusky, and thrice as long as second; seta, black; entire hinder part of head covered with dense white hairs. *Thorax,* more decidedly blue than in *leucaniæ, broader* (instead of narrower) in front than behind; the vittæ less distinct; scutel of same color as thorax. *Abdomen,* stout and more cylindrical than in *leucaniæ;* first joint dark bluish-gray; second, light bluish-gray, becoming darker along the middle, at sides and at lower border; third joint, like second above, but golden-gray at sides (no rufous); last joint *entirely* yellow or pale orange, with no other color and but few black bristles around anus. *Wings* more dusky than in *leucaniæ;* alulæ, opaque bluish-white. *Legs,* black; pulvilli pale yellow.

Described from one captured, 4 bred ♀. Space between eyes at occiput fully one-third the width of head.

[Fig. 19.]



To give an idea of the other parasites which attack the Army-worm, I will briefly allude to them, and transmit descriptions for the scientific reader.

THE GLASSY MESOCHORUS—*Mesochorus vitreus,* Walsh. (Fig. 19.)—Length of body .08 inch, (two millimetres,) to .13 inch, (three millimetres); the small specimens being parasitic on the Army-worm and the large ones captured in Rock Island county. Male, general color light rufous. Eyes and ocelli, black; antennæ fuscous, except toward the base. Upper surface of thorax in the larger specimen fuscous; intermediate and posterior tibiæ with spurs equal to one-fourth of their length; posterior knees slightly dusky; tips of posterior tibiæ distinctly dusky. Wings hyaline; nervures and stigma, dusky. Abdomen, a translucent yellowish-white in its central one-third; the remaining two-thirds piceous-black, with a distinct narrow yellowish annulus at the base of the third joint. In the larger specimen, which seems to be immature, the basal abdominal joint, and the articulations of the terminal joints are light rufous. Appendiculum of the abdomen composed of two extremely fine setæ, thickened at their base, whose length slightly exceeds the extreme width of the abdomen.

The female differs from the male, in the head from the mouth upwards being piceous. The thorax and pectus, in all three specimens, are also piceous-black. Abdomen as in the smaller male. Ovipositor, which is dusky, slightly exceeds in length the width of the abdomen.

THE DIMINISHED PEZOMACHUS—*Pezomachus minimus,* Walsh, (Fig. 20.).—Length of the body .07 to .10 inch., (2 to $2\frac{1}{2}$ millimetres). Male, general color, piceous. Eyes black; antennæ black, except toward the base, where they are light rufous. Legs rufous; hind legs a little dusky. Abdomen narrowed; second and sometimes the third joint annulate with rufous at tip. The female differs from the male in the thorax being almost invariably rufous, and in the first three abdominal joints being generally entirely rufous, with a piceous annulus at the base of the third, which is sometimes absent. The abdomen is also fuller and wider. Ovipositor dusky, equal in length to the width of the abdomen. No vestige of wings in either sex, and the thorax contracted and divided as in *Formica.*

[Fig. 20.]

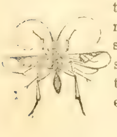
[Fig. 21.]

Fig. 22.]

The larvæ of this species issue from the body of the Army-worm, and spin on its skin, small cocoons symmetrically arranged side by side, and enveloped in floss (Fig. 21). It belongs to a genus of wingless Ichneumons, and in its turn is preyed upon by a small *Chalcis* fly (*Chalcis albifrons,* Walsh) which is represented at Figure 22.

THE MILITARY MICROGASTER—*Microgaster militaris,* Walsh, (Fig. 23).—Length 0.07 inch. Head black; palpi whitish; antennæ fuscous above, light brown beneath towards the base. Thorax black, polished, with very minute punctures. Wings hyaline; nervures and stigma fuscous; lower nervure of marginal, and exterior nervure of second submarginal cellule entirely obsolete. Lower nervule of third and terminal submarginal cellule, hyaline. Legs light rufous, posterior pair, with knees and tips of tibiæ fuscous. Abdomen black, glabrous, highly polished. Ovipositor not exserted.

[Fig. 23.]



The cocoons of this little parasite are spun in irregular masses, and are so completely covered with loose white silk that as a whole they look like little pieces of fine wool attached to the back of the Army-worms. They were very numerous last year in this State, and were sent to me by several correspondents, under the supposition that they were the eggs of the Army-worm. Nothing could be more unsafe and erroneous than such a conclusion; for instead of giving birth to new generations of the Army-worm they produce the little flies which are its most deadly foes. All the numerous specimens which I bred accord exactly with the above named species. This parasite is also in its turn infested by two parasites (*Glyphe viridascens* (Fig. 24) and *Hockeria perpulcra*, Walsh), but while over 90 per cent. of Army-worms are killed by primary parasites, only about 18 per cent. of these primary parasites are destroyed by the secondary parasites.

[Fig. 24.]

1

THE PURGED OPHION—*Ophion purgatus*, Say*.—Body pale honey-yellow, somewhat sericeous; antennæ rather longer than the body; orbits yellow, dilated before, so as to occupy the greater part of the hypostoma; ocelli large, prominent; wings hyaline; stigma slender; first cubital cellule with two opaque, subtriangular spots; no areolet; metathorax with a single, raised, rectilinear, transverse line, near the base. Length, seven-tenths of an inch.

[Fig. 25.]

This large Ichneumon Fly (Fig. 25) has been bred from the Army-worm. The ovipositor is very short, and instead of piercing the skin of her victim as do all the other Ichneumons that have been described, the female Ophion simply attaches her egg, which is bean-shaped, by a pedicle to the skin. The footless grub which hatches from this egg does not entirely leave the egg-case, but the last joints of its body remain attached to the shell, while it reaches over, and with its sharp jaws gnaws into the side of the worm (Packard). This Ophion has been taken in Maine, New York, Massachusetts, Indiana, Illinois, Missouri and Carolina and doubtless occurs all over the United States.

THE ARMY-WORM ICHNEUMON FLY—*Ichneumon leucaniæ*, Fitch.—Dr. Fitch* has briefly described another true Ichneumon Fly under the above name, which he bred from the Army-worm.

Thus we have seven distinct and true parasites which attack this worm, and besides these, two others, undescribed, are figured in Harris's Injurious Insects (last edition p. 630), swelling the number to nine. Can we longer wonder that this dreaded foe to the farmer, never molests his crops for two successive years?

HABITS OF THE ARMY-WORM, AND SUGGESTIONS FOR ITS DESTRUCTION.

Since the great bulk of the eggs of the Army-worm are deposited in the summer and fall months in grass swamps and grass mead-

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* *Ophion purgatus*, Say.=*O. lateralis*, Brullé.

*N. Y. Reports, Vol. III, p. 126.

ows, and the eggs do not hatch out till the following spring, it becomes obvious that burning over grass meadows in the winter or very early in the spring, must destroy most of the eggs. Many instances might be given where, in past years, burnt grass escaped the worm, while all the unburnt grass in the neighborhood was badly infested, and in one instance part of a meadow having been accidentally burnt and part remaining unburnt, the burnt portion in the following summer, had no Army-worms on it, and the unburnt portion swarmed with them. Thus, if you burn your meadows over annually you will seldom be troubled with this pest, and if you get your neighbors to do the same thing, and in addition will also burn all the wild grass around you, the Army-worm will never do you any damage. The remedy is so simple that all can apply it. The best time to do this burning, is, as all practical men well know, in the dead of the year, when the ground is frozen; the roots of the grass are then unharmed by the fire. Of course, ploughing the land late in the fall or late in the spring, will have the same effect as burning it, for if the eggs are turned two or three inches underground they will surely rot and fail to hatch. Here we see, as in the case of the Canker-worm, which I shall presently treat of, and as in the case of almost every other noxious insect, it is necessary accurately to investigate the habits and puculiarities of each one before we can effectually counterwork it.

During my visit to Hannibal last June, I ascertained that the worms orignated in a large 100-acre field of very rich blue-grass, belonging to Mr. W. R. Flowerree. This gentleman makes a business of fattening cattle, and intended feeding off the grass in the fall; but that same blue-grass field *had neither been pastured nor plowed the year before;* and this was the very reason why the worms originated there, as the reader will readily perceive from the foregoing account of the insect's habits.

The Army-worm when traveling will scarcely turn aside for anything but water, and even shallow water-courses will not always check its progress; for the advance columns will often continue to rush head-long into the water until they have sufficiently choked it up with their dead and dying bodies, to enable the rear guard to cross safely over. I have noticed that after crossing a bare field or bare road where they were subjected to the sun's rays, they would congregate in immense numbers under the first shade they reached. In one instance I recollect their collecting and covering the ground five or six deep all along the shady side of a fence for about a mile, while scarcely one was seen to cross on the sunny side of the same fence. Though they will nibble at clover, they evidently do not relish it, and almost always pass it by untouched. They will eat any of the grasses, and are fond of oats, rye, sorghum, corn and wheat, though they seldom devour any other part but the succulent leaves. They often cut off the ears of wheat and oats and allow them to fall to the ground, and they are perhaps led to perform this wanton trick, by the succulency of the stem immediately below the ear. South of latitude 40° they generally appear before the wheat stalks get too hard, or early enough to materially injure it; but north of that line, wheat is generally too much ripened for their tastes, and is sometimes even harvested before the full grown worms make their advent.

I have heard of the Army-worm, sometimes passing through a wheat field when the wheat was nearly ripe, and doing good service by devouring all the chess and leaving untouched the wheat; but the following item from Collinsville, Illinois, which appeared in the *Missouri Democrat*, contains still more startling facts, and would indicate that even a foe to the farmer as determined as this, may sometimes prove to be his friend.

"Harvest and Crops.—Notwithstanding the unfavorable weather, many farmers have commenced the wheat harvest. The yield in this immediate vicinity will be superabundant. Some fields were struck with rust a few days since, but the Amry-worm making its appearance simultaneously, stripped the straw entirely bare of blades and saved the berry from injury. These disgusting pests have saved thousands of dollars to farmers in this neighborhood. A few fields of corn and grass have been partially destroyed, but by ditching around fields, the worm's ravages have been confined within comparatively narrow limits."

The worms may be prevented from passing from one field to another by judicious ditching. Mr. Trabue has large meadows, separated only by a road from the blue-grass field of Mr. Flowerree; and he thought he could keep out the worms by simply making a V-shaped ditch; believing that they could not crawl over, so long as the earth crumbled. The first evening after it was dug, this ditch seemed to be effectual, and the bottom was covered with one seething, twisting mass of the worms; but a heavy rain came on in the night following, after which they crossed without difficulty. Mr. Jas. Dimmitt however, who had 80 acres of wheat adjoining the fatal blue-grass field, effectually protected it by surrounding it with a ditch which had the inner side slanting under, towards the field it was intended to protect. It was indeed most fortunate that Mr. Dimmitt had hit upon the true method in the beginning, for his wheat was yet in that soft state, in which many of the ears would have been devoured or cut off; and friend Trabue was not long in profiting by his example.

A good plan to destroy the worms which accumulate in the furrow or ditch is to burn straw in it; for the fire not only kills the worms, but makes the earth in the ditch friable and more efficient in preventing their ascent. A heavy roller passed over a field will kill almost every worm, and I have already stated that hogs and poultry will devour great numbers of them. But it is always better and easier to prevent than to cure.

Leucania unipuncta, Haw.—*Larva*—General color dingy black, with the piliferous spots, placed in the normal position, but scarcely visible, though the soft hairs arising from them are easily seen with a lens. Four lateral light lines, of almost equal thickness, and at about equal distance from each other, the two uppermost white, the two lowermost yellow; a much less distinct dorsal white line, frequently obsolete in middle of segment, and always most distinct at the divisions: a jet black line immediately above the first lateral white one, the dorsum near it, thickly mottled with dull yellow, but becoming darker as it approaches the fine dorsal white line, along each side of which it is perfectly black. Space between lateral light lines 1 and 2, dull yellow, the white lines being relieved by a darker edge; that between lines 2 and 3 almost black, being but slightly mottled along the middle; that between 3 and 4 yellow, mottled with pink-brown, and appearing lighter than that between 1 and 2. Venter greenish-glaucous, mottled and speckled with neutral color, especially near the edge of the 4th lateral line. Legs glassy and of same color as venter, those on thoracic segments with black claws, those on abdomen with a large shiny black spot on the outside. Stigmata oval, black, and placed in the 3d lateral light line. Head pale grayish-yellow, speckled with confluent fuscous dots; marked longitudinally by two dark lines that commence at the corners of the mouth, approach each other towards the centre, and again recede behind; on each side are four minute polished black eyelets, placed on a light crescent-shaped ridge, and from each side of this light ridge a dark mark extends more or less among the confluent spots above. Described from numerous average living specimens.

Imago—Front wings: general color tarnished yellowish-drab, inclining to russet; sprinkled with blackish atoms, the basal half of the costal margin being lighter than the rest. Ordinary spots brighter than rest of wing, being either fulvous or rust-red, each having ordinarily a tarnished centre, the reniform or "kidney-shaped" spot, having at its lower border a conspicuous white point, indistinctly surrounded by blackish, from which point the moth takes its name; between this point and the terminal border a transverse row of black dots (one on each vein) much arcuated above; and inside and parallel with it a less distinct row, the dots forming which, are between the nerves; an oblique dark streak, shaded off gradually posteriorly, but relieved anteriorly by the same bright color as the ordinary "spots" runs from the head of this row of dots to the apex of the wing; nerves more or less marked with white, especially towards their tips; posterior or terminal border with a row of black spots between the nerves; fringes same color as wing, with a narrow dusky line inside their middle. Hind wings partly transparent, smoky-brown, with a slight purplish lustre, the veins, lunule, and terminal border more dusky; fringes pale yellow with a dusky middle line.

Under surfaces opalescent yellowish-white, the front wings shaded with smoky-gray, the costa narrowly, and the terminal margin broadly freckled with dusky specks, the fringes and a shade near the apex flesh-color, and a distinct dusky band across their outer one-fourth, narrower but darker on the costa than in the middle of the wing: the hind wings with the lunule distinct and also speckled anteriorly and posteriorly, the basal edge of the posterior portion well defined by a series of black dots on the nerves.

Head and shoulders of same color as basal part of costa; thorax same as front wings; abdomen same as hind wings; beneath all more uniformly gray.

INSECTS INFESTING THE SWEET-POTATO.

TORTOISE-BEETLES.

(Coleoptera, Cassidæ.)

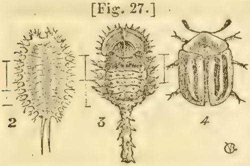
In my First Report I described eleven different and distinct insects which habitually prey on the common Irish Potato (*Salanum tuberosum*). I will now give an account of the worst insect enemies of the Sweet-Potato (*Ipomea batatus*), all of which attack that plant in this State. Before doing so, however, it will be as well to remark, that one species belonging to the same family as those which feed on the Sweet-Potato, and which is quite frequently met with in Missouri, namely, the Clubbed Tortoise-beetle (*Deloyala clavata*, Oliv. Fig. 26,)

[Fig. 26.]

feeds in reality on the common Irish Potato, thus swelling the number of insects which injuriously affect that most valuable esculent, to a round dozen. The larva of the Clubbed Tortoise-beetle is not yet known, and it is the perfect insect which has been found to attack the Potato. This is doubtless the species which Mr. Huron Burt of Williamsburg, Callaway county, referred to in the *Journal of Agriculture* of June 6th, 1868, as "a scale-like, terrapin-shaped hard insect, spread out like a flying-squirrel," that adhered tenaciously to the leaves of his potato plants. By referring to Figure 26 the reader will not be slow to learn why these beetles are called Tortoise-beetles, for the patches of dark opaque color which extend on the thin projecting semi-transparent shell of that species, remind one very forcibly of the paws of a mud-turtle. The true legs however, which, as in all other insects, are six in number, and which in this species, are so short that they scarcely reach beyond the thin shield-like crust that extends from the body, may readily be seen when the insect is turned upside down.

The insects which attack the Sweet-Potato are few in species, and belong almost entirely to this group of Tortoise-beetles. With

[Fig. 27.]



the exception of the Cucumber Flea-beetle (*Haltica cucumeris*, Harr.), figured and described on page 101 of the First Report, and a few solitary caterpillars, I have never found any other insects on this plant; but these Tortoise-beetles are of themselves sufficiently numerous in individuals and species to often entirely destroy whole fields of this esculent, and they are especially severe on the plants when newly transferred from the hot-bed.

These insects are at present included in the great CHRYSOMELA family of beetles, though they were formerly placed in a separate family (CASSIDIDÆ) by themselves, and there certainly are few groups more strongly characterized. They are almost all of a broad subdepressed form, either oval or orbicular, with the thorax and wing-covers so thoroughly dilated at the sides into a broad and flat margin, as to forcibly recall the appearance of a turtle, whence the popular name. Many have the singular power, in a greater or less degree, of changing their color when alive, and as I shall show further on, some of them shine at will with the most brilliant metallic tints.

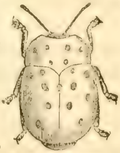
Insects, as with the higher animals, usually void their excrement in such a manner that they effectually get rid of it, and in some cases they take pains to fling it as far from them as possible, by means of their hind legs. I have especially noticed this cleanly habit in the Oblong-winged Katydid (*Phylloptera oblongifolia*, DeGeer), of which I have had numbers breeding in confinement during the past two summers. They almost always fling their excrement straight from them, so that if they are in a horizontal position, it adheres to the sides of their cages instead of falling to the bottom. In the great majority of insects the anus is situated at, or near the last ring, and usually on the ventral side, so that the fæces are easily left behind; but the larvæ of several species of beetles that have the peculiar habit of covering themselves with their own excrement, have the anus not on their bellies, but on their backs. The Three-lined Leaf-beetle* (*Lema trilineata*) has this habit, and is enabled to cover itself by the singular position of the anal vent which is on the back of the last segment. A closely allied European species, but belonging to a different genus (*Crioceris merdigera*) has the same habit. In this country there is also another yellowish oval jumping beetle (*Blepharida rhois*, Forster), which in the larva state covers itself with its excrement. In this instance the anus is at the end of the last segment, but it is sufficiently extensile at the will of the insect to allow of the accomplishment of the feat. This last larva is a disgusting looking thing, and I found it last year very abundant along the line of the Iron Mountain Railroad, on all three of the Sumachs—*Rhus aromatica*, *glabra* and *copalina*—preferring them in the order of their naming.

But the larvæ of the Tortoise-beetles are *par excellence* the true dung carriers, for they excel all others in this medigerous art. In the instances related above, the load is carried immediately on the back, but our Tortoise-beetles are altogether more refined in their tastes, and do not allow the dung to rest on the body, but simply shade themselves with a sort of stercoraceous parasol.

The larvæ of all the species that have been observed to feed on the Sweet-Potato are broad and flattened like the beetles, and have the margin of the body furnished with spines which are often barbed, (Fig. 27, 2). They all belong to the genera *Cassida* and *Coptocycla*, and there are thirty-two of these spines, or sixteen on each side of the body. Four of these are situated on the prothorax, which forms two anterior projections beyond the common margin; four of them—the two anterior ones longer than the others—are on each of the two following thoracic segments, and each of the abdominal segments is furnished with but two. There are nine elevated spiracles each side superiorly, namely, one immediately behind the prothorax and eight on the abdominal segments. The fore part of the body is projected shield-like over the head, which is retractile and small.

[Fig. 28.]

[Fig. 29.]

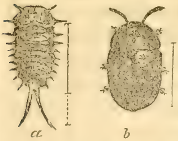


In a closely allied genus (*Chelymorpha*) to which belongs a brick-red insect with black spots (*Ch. cribraria*, Fabr., Fig. 28, pupa; 29 beetle) found upon Milkweed (*Asclepias*), and which has the body greatly rounded above, with scarcely any lateral flange, the larva, as observed by Dr. Packard, has the prickles smooth and not

*First Rep., p. 100.

sprangling. In another genus also (*Physonota*) to which belongs the Five-dotted Tortoise-beetle (*Ph. quinquepunctata*, Walsh & Riley, Fig. 30, *b*), and which is intermediate in form between the last named genus (*Chelymorpha*) and those with the body greatly flattened (*Cassida*, *Coptocycla*, *Deloyala*) the prickles of the larva are also smooth and only 20 in number, i. e., 10 on each side, as may be seen by referring to Figure 30, *a*. Mr. Walsh found this insect in Northern Illinois, and though we do not know upon what particular plant it feeds, yet from analogy we may infer that it subsists on some Composite flower, as other species belonging to the same genus are known to do.

[Fig. 30.]



a *b*

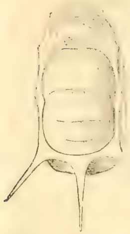
Almost all the larvæ of the beetles belonging to the great CHRYSOMELA family, of which the Colorado Potato Bug may serve as an example, have, besides the six legs at the anterior end of the body, an additional proleg, or protuberance which serves as such, at the posterior end; but the larvæ of our Tortoise-beetles have no such proleg, and the six anterior legs are short, thick and fleshy, and with the retractile head, give these larvæ, from a side view, as great a resemblance to a turtle as have the beetles.

Though lacking an anal proleg, however, they are characterized by having a movable forked tail, in the shape of two long prong-like horny filaments which both spring from a broad neck situated immediately above the anus. The anus projects and curves over the back at the will of the insect, and by the aid of this fork and of some of the lateral spines, it forms the parasol of dung which so nicely protects it.

When we read of those Hottentots who cover different portions of their bodies with the uncleaned intestines of sheep and oxen, we feel shocked at such barbarism, and can scarcely comprehend how human beings can defile themselves with the like disgusting materials. Such men must be pitiable indeed, for they can have no other object than the gratification of their filthy and beastly pleasures. There is nothing so repulsive about our insect Hottentots, for the dung parasol of our Tortoise-beetles has neither offensive odor or appearance, and its true character is generally sufficiently disguised by being intermixed with the cast-off skin and prickly spines; and though those species, first referred to, which directly cover their backs, often look sufficiently unclean, we know that they thus act at Nature's bidding and for a useful purpose.

All the Tortoise-beetle larvæ which I have bred to the perfect beetle state, have come to their growth in about three weeks after hatching. They cast their skins at three successive periods, and these skins are slipped on to the fork, where in most instances they remain. On carefully detaching from a full grown larva the dung with which these skins are mixed, these three successive skins are easily recognized, the smallest being at the extremity and the largest at the base of the fork. They are especially recognizable in the Mottled Tortoise beetle (*Cassida guttata*, Oliv., Fig. 36,) mentioned below, which removes most of its dung before each moult.

Fig. 31.



The eggs from which these larvæ hatch, are deposited singly upon the leaves, to which they are fastened by some adhesive substance. They are of irregular angular form; flat, and somewhat narrower at one end than the other; ridged above and at the sides, but smooth and obovate below. They are usually furnished with spine-like appendages, which however are sometimes entirely lacking. They look, in fact, very much like miniature specimens of those curious skate-barrows or Mermaid's purses, which are found so commonly along the sea-shore, and which are the empty egg-shells of certain kinds of Ray-fish or Skate. Those of the common Golden Tortoise-beetle (Fig. 31,) are 0.04 inch long, and of a dull, dirty white color.

The Tortoise-beetle larvæ, when full grown, fasten the last two or three joints of the body to the underside of a leaf, by means of a sticky secretion, and in about two days change to pupæ. The pupa of those species which have 32 barbed spines, is flat with usually four or five broad but thin and transparent serrated leaf-like appendages on each side of the abdomen, and the prothorax, which is greatly dilated and covers the head, is furnished around the edge with smaller barbed spines. The broad leaf-like spines at the edges of the body are bent under while the transformation is being effected, but are soon afterwards stretched stiffly out with a forward slant. The pupa loses the pronged tail, but as the old larval skin is left adhering to the terminal segments the prong of dung still protects it in most cases. The legs and antennæ are not free in this, as in the pupæ of most other beetles, but are soldered together as in the chrysalis of a butterfly, and yet it has the power of raising itself up perpendicularly upon the tail end by which it is fastened. The pupa state lasts about a week.

Having thus spoken in general terms of this anomalous group of beetles, I shall now refer more particularly to a few of the species. Most of those mentioned below infest the Sweet-Potato both in the larva and perfect beetle states. They gnaw irregular holes and when sufficiently numerous entirely riddle the leaves. They usually dwell on the underside of the leaves, and are found most abundant during the months of May and June. There must be several broods during the year, and the same species is often found in all stages, and of all sizes at one and the same time. In all probability they hybernate in the beetle state.

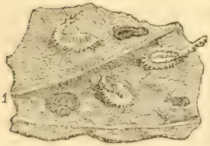
I have proved by experiment that Paris green—one part of the green to two of flour—when sprinkled under the vines, will kill these insects, though not near so readily as it does the Colorado Potato

Bug. Moreover, as these Tortoise-beetles usually hide on the under side of the leaves, and as the vines trail on the ground, it is very difficult to apply the powder without running some risk from its poisonous qualities. I therefore strongly recommend vigilance when the plants are first planted, and by the figures and descriptions given below the reader will be enabled to recognize and kill the few beetles which at that time make their appearance, and thus nip the evil in the bud. The Bermuda and Brazilian Sweet-Potato plants are more vigorous than the Nansemond, and less liable to be attacked.

THE TWO-STRIPED SWEET-POTATO BEETLE—*Cassida bivittata,*, Say.

This is the most common species found upon the Sweet-Potato, and seems to be confined to that plant, as I have never found it on any other kind. Its transformations were first described by myself in the *Prairie Farmer Annual*, for 1868, (p. 53.) The larva (Fig, 27, 2 enlarged; Fig. 32, natural size), is dirty-white or yellowish-white, with a more or less intense neutral-colored longitudinal line along the back, usually relieved by an extra light band each side. It differs from the larvæ of all other known species in not using its fork for merdigerous purposes. Indeed, this fork is rendered useless as a shield to the body, by being ever enveloped, after the first moult, in the cast-off prickly skins, which are kept free from excrement. Moreover, this fork is seldom held close down to the back, as in the other species, but more usually at an angle of 45° over or from the body, thus suggesting the idea of a handle. In Kirby & Spence's Introduction (p. 426), may be found the following passage in reference to the positions in which the fork of the larvæ of these Tortoise-beetles is carried: "The instrument by which they effect this is an anal fork, upon which they deposit their excrement, and which in some is turned up and lies flat upon their backs; and in others forms different angles, from very acute to very obtuse, with their body; and occasionally is unbent and in the same direction with it." Reaumur is referred to as authority for these statements, and the language would lead us to suppose that the forks were thus variously carried by different species; but Reaumur never said anything of the sort. His language has been poorly rendered, for he distinctly referred to the different positions which the same insect could give to the fork, and I believe that the peculiarity mentioned above has never been observed in the larvæ of any other species of the genus.

[Fig. 32.]



When full fed, this larva attaches itself to the underside of the leaf, and in two days the skin bursts open on the back, and is worked down towards the tail; when the pupa, at first pale, soon acquires a dull brownish color, the narrow whitish tail, which still adheres posteriorly, being significant of the species. See (Fig. 27, 3.)

The beetle (Fig, 27, 4) is of a pale yellow, striped with black, and though broader and vastly different scientifically, still bears a general resemblance to the common Cucumber-beetle (*Diabrotica vittata*, Fabr.)

These beetles may be seen quite thick around young peach and apple trees quite early in the season, and a little later they venture into the trees and pair off; but as soon as the Sweet-Potato plants are set, they leave everything else for them.

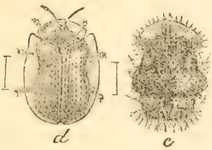
THE GOLDEN TORTOISE-BEETLE—*Cassida aurichalcea*, Fabr.

Next to the preceding species, the Golden Tortoise-beetle is the most numerous on our sweet-potatoes; but it does not confine its injuries to that plant, for it is found in equal abundance on the leaves of the Bitter-Sweet and on the different kinds of Convolvulus or Morning Glory. The lava (Fig. 33, *a*, natural size *b*, enlarged with the dung taken from the fork), is of a dark brown color with a pale shade upon the back. It carries its fæcifork directly over the back, and the excrement is arranged in a more or less regular trilobed pattern. The loaded fork still lies close to the back in the pupa, which is brown like the larva, and chiefly characterized by three dark shades on the transparent prothorax, one being in the middle and one at each side, as represented at Figure 34, *c*.

[Fig. 33.]

The perfect beetle (Fig. 34, *d*), when seen in all its splendor, is one of the most beautiful objects that can well be imagined. It exactly resembles a piece of golden tinsel, and with its legs withdrawn and body lying flat to a leaf, the uninitiated would scarcely suppose it to be an insect, did it not suddenly take wing while being observed. At first these beetles are of a dull deep orange color, which strongly relieves the transparent edges of the wing-covers and helmet, and gives conspicuousness to six black spots, two (indicated in the figure) above, and two on each side. But in about a week after they have left the pupa shell, or as soon as they begin to copulate, they shine in all their splendor, and these black spots are scarcely noticed.

[Fig. 34.]

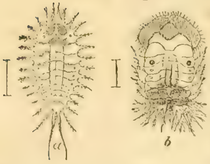


THE PALE-THIGHED TORTOISE-BEETLE—*Cassida pallida*, Herbst.

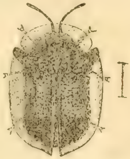
This species can scarcely be distinguished from the preceding. It is of a somewhat broader, rounder form, and differs in partially lacking the black spots on the wing-covers, and in having the thighs entirely pale yellow, while in *aurichalcea* they are black at the base. It likewise feeds upon the Sweet-Potato, and its larva differs only from that of the former, in its spines being brighter and lighter colored, and in having a dull orange head, and a halo of the same color on the anterior portion of the body.

THE MOTTLED TORTOISE-BEETLE—*Cassida guttata*,* Oliv.

[Fig. 35.]



[Fig. 36.]



This species (Fig. 36) which is the next most common of those found on the Sweet-Potato in the latitude of St. Louis, is at once distinguished from all the others here described, by being usually black, with the shoulders black to the extreme edge of the transparent wing-covers. It is a very variable species, and is frequently more or less speckled or mottled with gold, while more rarely it has a uniform golden appearance.†

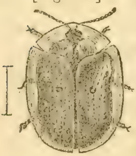
The larva, which is represented enlarged and with the dung removed at Figure 35, *a*, is of a uniform green color, with a bluish shade along the back, which shade disappears however whenever the insect has fasted for a few hours. It carries its dung in irregular broad masses, often branching as in the species next to be described. The pupa (Fig. 35, *b*,) is also of a uniform green color, with a conspicuous black ring around the base of the first abdominal pair of spiracles. Before changing to pupa and previous to each moult, this larva is in the habit of removing the dung from its fork.

THE BLACK-LEGGED TORTOISE-BEETLE—*Cassida nigripes*, Oliv.

[Fig. 37.]

This species, which is likewise found on the Sweet-Potato, is a little the largest of those heretofore mentioned. The beetle (Fig. 38) has the power, when alive, of putting on a golden hue, but is not so brilliant as *C. aurichalcea*, from which species it is at once distinguished by its larger size and by its black legs and three large conspicuous black spots on each wing-cover. The larva (Fig. 37, *b*,) is of a pale straw color with the spines, which are long, tipped with black; and besides a dusky shade along each side of the back, it has two dusky spots immediately behind the head, and below these last, two larger crescent marks of the same color. The dung is spread in a characteristic manner, extending laterally in long shreds or ramifications. (See Fig. 37, *a*.) The pupa

[Fig. 38.]



* This insect is referred by Boheman to the genus *Co tocycla*, which differs from *Cassida* by more slender, not distinctly clavate and nearly filiform antennæ.

† This species has very probably been described under different names. It is *C. cruciata*, Fabr.; *C. signifer*, Herbst, and from larvæ found on the same batch of plants, and differing in no respect whatever, I have bred specimens which were determined by Le Conte as *C. trabeata*, Lec.

(Fig. 37, *c*,) is dark brown, variegated with paler brown as in the figure, while the spines around the edges are transparent and white.

THE PICKLE WORM—*Phacellura nitidalis*, Cramer.

(Lepidoptera, Margarodidæ.)

As long ago as the year 1828, Dr. T. W. Harris described and named the common Squash Borer (*Ægeria* [*Trochilium*] *cucurbitæ*). This borer is a true caterpillar, having sixteen legs, and very much resembling the common Peach Borer. It is hatched in the early part of summer, from eggs placed by the parent moth on the stems of the vine, close to the root. It penetrates the stem, and by devouring the pith, frequently causes the death of the vine. When full fed it retreats a short distance into the ground and forms a cocoon of a gummy substance covered with particles of earth. Within this cocoon it passes the winter, and early the next summer issues as a moth. This moth is very beautiful, with a conspicuous orange-colored body spotted with black; with the front wings blue-black and with the hind wings perfectly transparent.

Ever since the day when it was first described by Harris, this insect has been known as the Squash Borer. It seems to be confined, however, to a few of the more Eastern States, and although Mr. Wm. Klussman, of Pine Bluff, Arkansas, thinks he is troubled with this species, and has given up the growing of all winter squashes in consequence of its ravages (*Country Gentleman*, Nov. 11, 1869, page 378), yet it certainly is not of common occurrence in the Valley of the Mississippi, or we should more often hear of it.

There is, however, another borer which attacks the roots of cucurbitaceous vines, and which is but too common all over the country. I refer to that ubiquitous little pest the Striped Cucumber-beetle (*Diabrotica vittata*, Fabr.) an insect which annually destroys thousands of dollars' worth of vines in the United States, and for which remedies innumerable—some sensible, but the greater portion not worth the paper on which they are printed—are published every year in our different agricultural papers.

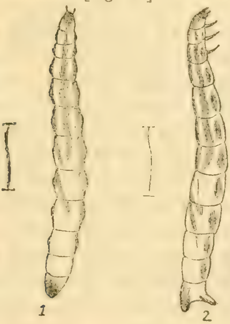
The natural history of this "Striped Bug," as it is more commonly called, was first made known in the West by Dr. Henry Shimer, of Mt. Carroll, in the *Prairie Farmer*, for August 12, 1865. But as everything pertaining to such a very common and destructive insect, cannot be too often repeated, I will here relate its habits in the briefest manner.

[Fig. 39]

The parent beetles (Fig. 39) make their appearance quite early in the season, when they immediately commence their work of destruction. They frequently penetrate through the cracks that are made by the swelling and sprouting of the seeds of melons, cucumbers, or squashes, and by nipping off the young sprouts, destroy the plant before it is even out of the ground.

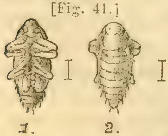
Their subsequent work when the vines have once pushed forth their leaves, is too well known to need description. Yet notwithstanding the great numbers and the persistency of these beetles, we finally succeed, with the proper perseverance and vigilance, in nursing and protecting our vines, till we think they are large enough to withstand all attacks. Besides, by this time, the beetles actually begin to diminish in numbers, and we congratulate ourselves on our success. But lo! All of a sudden, many of our vines commence to wilt, and they finally die outright. No wound or injury is to be found on the vine above ground, and we are led to examine the roots. Here we soon discover the true cause of death, for the roots are found to be pierced here and there with small holes, and excoriated to such an extent, that they present a corroded appearance. Upon a closer examination the authors of this mischief are easily detected, either imbedded in the root, or lurking in some of the corroded furrows. They are little whitish worms, rather more than a third of an inch long, and as thick as a good sized pin; the head is blackish-brown and horny, and there is a plate of the same color and consistency on the last segment. These worms are in fact the young of the same Striped Bug which had been so troublesome on the leaves earlier in the season; and that the insect may be as well known in this, its masked form, as it is in the beetle state, I present the annexed highly magnified figures of the worm (Fig. 40), No. 1 showing a back view and No. 2 a side view. The beetles, while feasting themselves on the tender leaves of the vine, were also pairing, and these worms hatched from the eggs which were deposited near the roots by the female. When the worms have become full-grown, which is in about a month after they hatch, they forsake the roots and retire into the adjoining earth, where each one, by continually turning around and around, and compacting the earth on all sides forms for itself a little cavity and in a few days throws off its larva skin and becomes a pupa. This pupa is much shorter than was the worm, and is represented enlarged in the annexed Figure 41, No. 1 ventral view, and No. 2 back view, the hair lines at the sides showing the natural size. This pupa state lasts about two weeks, at the end of which time the skin is again moulted, and the perfect beetle form assumed. All the parts of this newly developed beetle are at first soft, but after remaining motionless in its cell, till these soft parts have acquired solidity and strength, it breaks through the walls of its prison and works itself up to the light of day.

[Fig. 40.]



1 2

[Fig. 41.]



1. 2.

There are from two to three generations each year, the number varying according to the latitude, or the length of the winter. To show however, how the different broods run into one another, and to prove how difficult it is to separate them by distinct lines, I will state that at Kirkwood, Mo., I found this insect abundant in its three stages of larva, pupa, and beetle, during the first days of October last. And in a large jar partly filled with earth, in which I placed a number of infested roots about that time, I to-day (Nov. 8, 1869) find both pupæ and beetles. The soil in this jar was kept as nearly as possible in the same condition as that out of doors, and as I noticed the beetles around the vines even after the first frosts, I am led to infer that, in this latitude at least, the insect often hybernates as a beetle, and not always as a pupa, as intimated by Dr. Shimer.

Of all the multifarious remedies proposed against the attacks of this insect, there are none so effectual or so cheap in the end, as inclosing the young vines in boxes which are open at the bottom, and covered with millinet on the top. Such boxes are made at a trivial cost, and if properly stored away each season after use, will last for many years. Whenever other remedies must from necessity be resorted to, there is nothing better than sprinkling the vines, early in the morning with Paris-green and flour, (one part of the green to four or five of flour) or with white hellebore. It of course follows, that if the beetles are effectually kept off, there will afterwards be no worms at the roots.

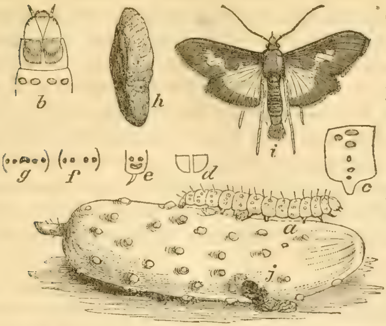
Much complaint was made last summer, in various parts of the country, of the sudden death of cucurbitaceous vines, from some unknown cause, and Henry Ward Beecher seems to have suffered in this manner, like the rest of us, but could find no worms in the roots of his vines. I know from experience that such vines are subject to a species of rot in the root—a rot not caused by insects, and for that reason the more serious, since we cannot tell how to prevent it. I have seen whole melon patches destroyed by this rotting of the roots, but in the great majority of instances where I have examined vines that had died from "some unknown cause," I have had no difficulty in either finding the worms of the "Striped Bug" yet at work on the roots, or else the unmistakable marks of their having been there. Indeed, by the time a vine dies from the effects of their gnawings and burrowings, the worms have generally become fully grown, and have hidden themselves in their little pupal cavities.

So much for the two borers which have heretofore been known to attack plants belonging to the Gourd family. We have seen how they both bore into the roots of these plants, and how one of them in the perfect state attacks the leaves. No other borers have been known to attack these plants, though the 12-Spotted Diabrotica (*D. 12-punctata*, Fig. 42), may often be found embedded in the rind of both melons, cucumbers and squashes. But we now come to a third insect which attacks plants of this same Gourd family. It neither bores into the root, nor devours the foliage, however, but seems to confine itself to the fruit; and I have

[Fig. 42]

called it the Pickle Worm, from the fact of its often being found in cucumbers that have been pickled.

[Fig. 43]



At Figure 43, *a*, I represent one of these worms of the natual size. They vary much in appearance, some being of a yellowish-white, and very much resembling the inside of an unripe melon, while others are tinged more or less with green. They are all quite soft and translucent, and there is a transverse row of eight shiny, slightly elevated spots on each segment, and an additional two behind the others on the back. (See Fig. 43, *c*.) Along the back and towards the head, these spots are larger than at the sides, and each spot gives rise to a fine hair. The specimen from which I obtained my first moth last summer was very light colored, and these spots were so nearly the color of the body as to be scarcely visible. The head was honey-yellow bordered with a brown line and with three black confluent spots at the palpi.

The cervical shield or horny plate on the first segment was of the same color as the body, and so transparent that the brown border of the head when retracted shone distinctly through it as at Figure 43, *b*. The breathing-holes or stigmata are small, oval, and of the same color as the body, with a fulvous ring around them. In some of the young worms the shiny spots are quite black and conspicuous. My late associate, Mr. Walsh, communicated to me the following description of such a marked specimen, from which he bred the very same species of moth as from the paler individuals: The description was taken when the worm was but half grown.

Length ½ inch. Color pale greenish-yellow; 16 legs. Head pale rufous, the Y-shaped sutures and the mouth black. Cervical shield as in Figure 43, *d*, each half edged with black, center rufous. Marked under shield on each side as at *e*, and the same lateral marking on joints, 2 and 3. Above on joints 2 and 3 as at *f*. On joints 4–11, eight (including 2 lateral) spots transversely arranged, and behind these, two dorsal spots. Of the eight spots the two lateral ones on each side are substigmatal. Stigmata edged with dusky. Anal joint with five spots as in *g*, the middle one large and transverse. Body with some sparse long dusky hairs, 6–8 times as long as wide, a little tapered toward the head. Spins a thread. Legs and prolegs nearly immaculate.

The worms commenced to appear in the latitude of St. Louis, about the middle of July, and they continued their destructive work till the end of September. They bore cylindrical holes into the fruit and feed on its fleshy parts. They are gross feeders and produce a large amount of soft excrement. I have found as many as four in a medium-sized cucumber, and a single worm will often cause the fruit to rot. They develop very rapidly and come to their growth in from three to four weeks. When about to transform they forsake the fruit in which they had burrowed, and drawing together portions of some leaf that lies on or near the ground, spin a slight cocoon of white silk. Within this cocoon they soon become slender brown chrysalids with the head parts prolonged, and with a very long ventral sheath which encloses the legs. If it is not too late in the season the moths issue in from eight to ten days afterwards. The late individuals, however, pass the winter within their cocoons; though, from the fact that some moths come out as late as November, I infer that they may also winter over in the moth state.

The moth produced by this worm (of which Figure 43, *i*, represents the male) is very strikingly marked. It is of a yellowish-brown color, with an iris-purple reflection, the front wings having an irregular, semi-transparent, dull golden-yellow spot, not reaching their front edge, and constricted at their lower edge; and the hind wings having their inner two-thirds of this same semi-transparent yellow. The under surfaces have a more decided pearly lustre. The thighs, the breast, and the abdomen below, are all of a beautiful silvery-white, and the other joints of the long legs are of the same tawny or golden-yellow as the semi-transparent parts of the wings. The abdomen of the female terminates in a small flattened black brush, squarely trimmed, and the segment directly preceding this brush is of a rust-brown color above. The corresponding segment in the male is, on the contrary, whitish anteriorly and of the same color as the rest of the body posteriorly, and he is, moreover, at once distinguished from the female, by the immense brush at his tail, which is generally much larger than represented in the above figure, and is composed of narrow, lengthened (*ligulate*) scales, which remind one of the petals of the common English daisy, some of these scales being whitish, some orange, and others brown. This moth was described nearly a century ago by Cramer, under the scientific name of *Phak*[*c*]*ellura nitidalis*, and it may be known in English as the Neat Cucumber Moth. The genus to which it belongs is characterized chiefly by the partly transparent wings, and by the immense scaly brush of the males. The antennæ are long, fine and thread-like, those of the male being very finely ciliated; the abdomen extends beyond the wings, and the legs are very long and slender. The species are for the most part exotic, and the larvæ of all of them, so far as known, feed on cucurbitaceous plants.

The following item, taken from a St. Louis paper, though somewhat facetious, will give an idea of the extent of the injuries caused by this insect in that vicinity:

What's the matter with the cucumbers? A lady of our acquaintance, the other day, sent to market to purchase some cucumbers for pickling purposes. They were placed in a vessel to be washed, previous to being put in the brine. It was then observed that small, singular looking worms clung in the 'wrinkles' on the outside of some of the cucumbers. These were washed off, when accident led to the discovery that inside every one of the cucumbers was secreted a white, corrugated, creeping thing, from half an inch to over an inch in length, resembling in miniature a rattlesnake's rattles, and not a very pretty object to look upon. It turns out that nearly, if not all the cucumbers brought to this market this season are affected the same way. These worms certainly do not look very good to eat, in the unpickled form; but we are told that they are entirely harmless in the natural state, and probably add to the pungency and crispness of the gherkin when forming part of the chow-chow, and other relishes which grace every well regulated square meal. Like the mites in the cheese, which with some are supposed to testify to the good quality and healthfulness of the article, we suppose worms in the pickles may fairly be considered a question of taste; but, if it is not obtrusive, we will add that we do not believe they are to *our* taste or digestion, and, if it is all the same to the cucumber merchants, we would rather not take any in our'n.

In Missouri, I have myself found this insect quite abundant in various parts of St. Louis and Jefferson counties, and the cucumbers seem to have fared worse than the melons. That it was not confined to these two counties, is also proved by the following communication which appeared in the *Journal of Agriculture*, of September 10, 1869:

Pleasant Hill, Mo., September 2, 1869. — Last winter, seeing many glowing accounts of the "Alton Large Nutmeg Melon," I sent to Mr. Barler and procured some, paying thirty cents an ounce for them; planted and worked well; during August, had some melons. The first few tasted right well, but soon my "Green Citron" cantelope ripening, the difference in the taste of the two was found to be so great that we could not eat the Alton Nutmeg. Furthermore, the latter had worms in them—the larvæ of some insect—eating into nearly every one. The Green Citron was rarely attacked by them. I have raised this variety of Green Citron for several years, and would not give one of the melons for a dozen Alton Nutmegs. It is sweet, juicy and very rich in taste. When a boy, I can remember a cantelope that was raised by my father, called "Persian." I think the Green Citron probably derived from it.

Yours, G. C. BROADHEAD.

In Illinois, it was very destructive around Alton, during the month of August; for, on July 19th, I received specimens from G. W. Copley, of that place, and found (Sept. 2, 1869), on visiting Mr. O. L. Barler's large melon fields, that fully three-fourths of his melons had been injured by it. Since then, several other Alton men have assured me that it was equally destructive with them. It also occurred around Springfield, for Mr. P. M. Springer sent to me, the last of October, a specimen of the moth which he had bred from a cucumber-boring worm; while Mr. Walsh also found it abundant at Rock Island, in the northern part of that State.

In Michigan, as I learned from Mr. W. B. Ransom, of St. Joseph, it greatly injured the cucumbers and melons around that place; and Mr. Glover, of the Department of Agriculture, informs me that he has found the worm on Squash, in Florida, in July. Thus it appears that this Pickle Worm has a wide range, and that last summer it simultaneously fell upon the cucumbers and melons in widely different parts of the country. Of course, in making pickles, the worm is pickled with the cucumber, and we shall consequently continue to hear startling stories about the worms in the pickles.

This insect, so far as I can ascertain, has never before been figured or described in this country; nor can I find any mention made of its destructive work in past years. I am, therefore, led to the conclusion that it was never numerous or destructive enough in the past, to attract attention. This fact becomes the more astonishing, when we consider how wide-spread and general its injuries were the past summer; and it furnishes another illustration of the sudden and enormous increase, in some particular year, of an insect which had scarcely ever before been noticed.

The system of Nature is so complicated, and every animal organism is subject to so many influences that affect its increase or decrease, that we are not surprised at the fluctuation in the relative numbers of any particular species. The "Struggle for Life," as expounded by Darwin, is no where more effectual in bringing about changes than in insect life. We are at first a little puzzled to account for the sudden advent, and the equally sudden departure of such insects as the Army-worm, Chinch Bug, Wheat Midge, etc., but when we once acquire a just conception of the tangled web in which every insect is involved, we wonder rather that the balance is so well kept.

Our Pickle-worm is an indigenous species, and has, doubtless, existed in some part or other of the country from time immemorial; and now that its habits are recorded and its history made known, I should not be at all surprised to learn that individuals have suffered from it in years gone by. The French Entomologist, Guenée, gives as its food-plant, a species of potato, and it is just possible that it may not always have fed upon the same plants on which it was found last summer. At all events, let us hope that it will disappear as suddenly as it appeared; but should it occur in great numbers again next year, the foregoing account will enable those who grow melons, cucumbers or squashes, to understand their enemy, and to nip the evil in the bud, by carefully overhauling their vines early in the summer, and destroying the first worms that appear, either by feeding the infested fruit to hogs or cattle, or by killing the worms on the spot. I know from experience that this worm when pickled with the cucumber, does not in the least affect its taste, and is not in the least injurious to the human system; but as it is not very desirable food, pickles should always be halved, before being brought to the table, especially if they were gathered from a field or garden known to be infested.

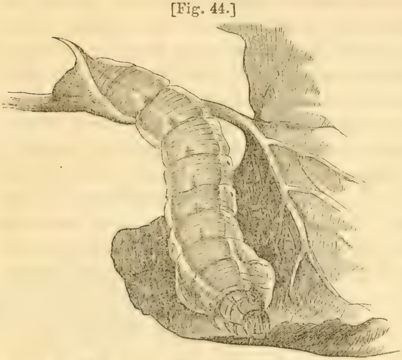
INSECTS INJURIOUS TO THE GRAPE-VINE.

Under this head, I shall continue the series of articles begun in my First Report, in order to give the grape-growers of our State a thorough understanding of their insect enemies, and thus lessen the hindrances and drawbacks to viticulture—that most important and pleasant part of rural industry, which is increasing with such unprecedented rapidity.

THE HOG-CATERPILLAR OF THE VINE—*Chærocampa pampinatrix*, Sm. & Abb.*

[Lepidoptera, Sphingidæ.]

[Fig. 44.]



Of the large solitary caterpillars that attack the Grape-vine, this is by far the most common and injurious in the Mississippi Valley. I have frequently found the egg of this insect glued singly to the underside of a leaf. It is 0.05 inch in diameter, perfectly round and of a uniform delicate yellowish-green color. The young worm which hatches from it, is pale green, with a long straight horn at its tail; and after feeding from four to five weeks it acquires its full growth, when it presents the appearance of Figure 44, the horn having become comparatively shorter and acquired a posterior curve.

This worm is readily distinguished from other grape-feeding species by having the third and fourth rings immensely swollen, while the first and second rings are quite small and retractile. It is from this peculiar appearance of the fore part of the body, which strikingly suggests the fat cheeks and shoulders and small head of a blooded hog, that it may best be known as the Hog-caterpillar of the vine. The color of this worm when full grown is pea-green, and it is wrinkled transversely and covered with numerous pale-yellow dots, placed

*Synonyms, *Sphinx*, [*Darapsa*] *myron*, Cramer; *Otus cnotus*, Huebner. Of the four different generic names under which this species has been classified, "*Sphinx*" is a general term for all the Hawk-moths and refers to the sphinx-like attitude often assumed by their larvæ; "*Chærocampa*" is derived from two Greek words which mean "Hog-caterpillar;" and "*Darapsa*" and "*Otus*" are gibberish. Of the three different specific names, "*Myron*" refers to an ancient Greek who bore this appellation, "*cnotus*" is pure unadulterated gibberish, and "*pampinatrix*" is from the Latin and signifies "a female vine-pruner." Both Harris and Fitch describe this insect under the name of *Chærocampa pampinatrix;* and this, as the appellation best known to our grape-growers, and the most characteristic of the habits of the species, I should prefer to retain, although no doubt, according to the strict Law of Priority, the specific name of *Myron* ought to be employed. Mr. Walker, Dr. Clemens and Dr. Morris call this species "*Darapsa Myron,*" and Mr. Grote calls it "*Otus Myron.*" By ringing the changes with sufficient ingenuity upon the four generic and the three specific names, we may obtain no less than twelve different names for this one insect!

in irregular transverse rows. An oblique cream-colored lateral band, bordered below with a darker green, and most distinct on the middle segments, connects with a cream-colored subdorsal line, which is bordered above with darker green, and which extends from the head to the horn at the tail. There are five and often six somewhat pale yellow triangular patches along the back, each containing a lozenge-shaped lilac-colored spot. The head is small, with yellow granulations, and four perpendicular yellow lines, and the spiracles or breathing holes are orange-brown. When about to transform, the color of this worm usually changes to a pinkish-brown, the darker parts being of a beautiful mixture of crimson and brown. Previous to this change of color Mr. J. A. Lintner, of Schoharie, New York, has observed the worm to pass its mouth over the entire surface of its body, even to the tip of its horn, covering it with a coating of apparently glutinous matter—the operation lasting about two hours.* Before transforming into the pupa or chrysalis state, it descends from the vine, and within some fallen leaf or under any other rubbish that may be lying on the ground, forms a mesh of strong brown silk, within which it soon changes to a chrysalis (Fig. 45.) of a pale, warm yellow, speckled and spotted with brown, but characterized chiefly by the conspicuous dark brown spiracles and broad brown incisures of the three larger abdominal segments.

[Fig. 45.]

[Fig. 46.]

The moth (Fig. 46) which in time bursts from this chrysalis, has the body and front wings of a fleshy-gray, marked and shaded with olive-green as in the figure, while the hind wings are of a deep rust color, with a small shade of gray near their inner angle.

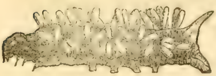
This insect is, in northerly regions, one-brooded, but towards the south two-brooded, the first worms appearing, in the latitude of St. Louis, during June and July, and giving out the moths about two weeks after they become chrysalids, or from the middle of July to the first of August. The worms of the second brood are full grown in September, and passing the winter in the chrysalis state, give out the moths the following May. On one occasion I found at South Pass, Illinois, a worm but one-half grown and still feeding as late as October 20th, a circumstance which would lead to the belief that at

*Proc. Ent. Soc., Phil., III, p. 663.

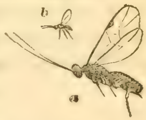
points where the winters are mild, they may even hybernate in the larva state.

This worm is a most voracious feeder, and a single one will sometimes strip a small vine of its leaves in a few nights. According to Harris it does not even confine its attacks to the leaves, but in its progress from leaf to leaf, stops at every cluster of fruit, and either from stupidity or disappointment, nips off the stalks of the half-grown grapes and allows them to fall to the ground untasted. It is fortunate for the grape-grower, therefore, that Nature has furnished the ready means to prevent its ever becoming excessively numerous, for I have never known it to swarm in very great numbers. The obvious reason is, that it is so freely attacked by a small parasitic Ichneumon fly—belonging to a genus (*Microgaster*) exceedingly numerous in species—that three out of every four worms that we meet with will generally be found to be thus victimized. The eggs of the parasite are deposited within the body of the worm, while it is yet young, and the young maggots hatching from them feed on the fatty parts of their victim. After the last moult of a worm that has been thus attacked, numerous little heads may be seen gradually pushing through different parts of its body; and as soon as they have worked themselves so far out that they are held only by the last joint of the body, they commence forming their small snow-white cocoons, which stand on ends and present the appearance of Figure 47. In about a week the fly (Fig. 48, *a*, magnified; *b*, natural size) pushes open a little lid which it had previously cut with its jaws, and soars away to fulfil its mission. It is one of those remarkable and not easily explained facts, which often confront the student of Nature, that, while one of these Hog-caterpillars in its normal and healthy condition may be starved to death in two or three days, another, that is writhing with its body full of parasites will live without food for as many weeks. Indeed, I have known one to rest for three weeks without food in a semi-paralyzed condition, and after the parasitic flies had all escaped from their cocoons, it would rouse itself and make a desperate effort to regain strength by nibbling at a leaf which was offered to it. But all worms thus attacked succumb in the end, and I cannot conclude this article to better advantage than by reminding the Grape-grower, that he should let alone all such as are found to be covered with the white cocoons above illustrated, and not, as has been often done, destroy them under the false impression that the cocoons are the eggs of the worm. Numbers of these little white cocoons are sent to me every year under the supposition that they are eggs, and no doubt many of them get destroyed by the very persons who ought to cherish them.

[Fig. 47.]



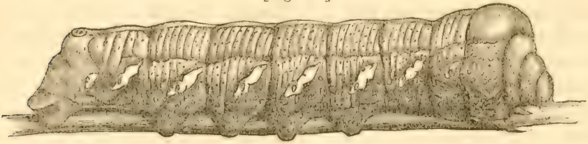
[Fig. 48.]



THE ACHEMON SPHINX—*Philampelus achemon*, Drury.*

(Lepidoptera, Sphingidæ.)

[Fig. 49.]



a

This is another of the large Grape-vine-feeding insects, belonging to the great *Sphinx* family, and which may be popularly known as the Achemon Sphinx. It has been found in almost every State where the Grape is cultivated, and also occurs in Canada. It feeds on the American Ivy (*Ampelopsis quinquefolia*, with as much relish as on

[Fig. 50.]

b

the Grape-vine, and seems to show no preference for any of the different varieties of the latter. It is, however, worthy of remark, that both its food-plants belong to the same botanical Family.

The full grown larva (Fig. 49.) is usually found during the latter part of August and fore part of September. It measures about 3½ inches when crawling, which operation is effected by a series of sud-

[Fig. 51.]

c

den jerks. The third segment is the largest, the second but half its size and the first still smaller, and when at rest the two last mentioned segments are partly withdrawn into the third as shown in the figure. The young larva is green, with a long slender reddish horn rising from the eleventh segment and curving over the back, and

*The synonyms for this insect are *Sphinx Crantor*, Cramer, and *Pholus crantor*, Huebner. The genus *Philampelus*—meaning literally "fond of the vine"—was erected by Harris to include this and the next species.

though I have found full grown specimens that were equally as green as the younger ones, they more generally assume a pale straw or reddish-brown color, and the long recurved horn is invariably replaced by a highly polished lenticular tubercle. The descriptions extant of this worm are quite brief and incomplete. The specimen from which my drawing was made, was of a pale straw color which deepened at the sides and finally merged into a rich vandyke-brown. A line of a *feuille-morte* brown, deep and distinct on the anterior part, but indistinct and almost effaced on the posterior part of each segment, ran along the back, and another line of the same color, continuous, and with its upper edge fading gradually, extended along each side. The six scalloped spots were cream-colored; the head, thoracic segments and breathing-holes inclined to flesh-color, and the prolegs and caudal plate were deep brown. The worm is covered more or less with minute spots which are dark on the back but light and annulated at the sides, while there are from six to eight transverse wrinkles on all but the thoracic and caudal segments.

The color of the worm, when about to transform, is often of a most beautiful pink or crimson. The chrysalis (Fig. 50) is formed within a smooth cavity under ground. It is of a dark shiny mahogany-brown color, shagreened or roughened, especially at the anterior edge of the segments on the back.

Unlike the Hog-caterpillar of the Vine, just described, this insect is everywhere single-brooded, the chrysalis remaining in the ground through the fall, winter and spring months, and producing the moth towards the latter part of June. I rather incline to believe however that there may be exceptions to the rule in southerly latitudes, and that in such latitudes it may sometimes be double-brooded; for I have known the moth to issue near St. Louis during the first days of August, and have this very year found two worms in the same locality as late as the 25th of October, neither of which was quite full grown, though the leaves on the vines upon which they were found had almost all fallen. Apparently such premature development of *Sphinx* moths is a well-known occurrence among the different European species; for Chas. Darwin remarks that "a number of moths, especially *Sphinx* moths, when hatched in the autumn out of their proper season, are completely barren; though the fact of their barrenness is still involved in some obscurity.*

The moth (Fig. 51), is of a brown-gray color variegated with light brown, and with the dark spots, shown in the figure, deep brown. The hind wings are pink with a dark shade across the middle, still darker spots below this shade, and a broad gray border behind. I once had an excellent opportunity of observing how it burst open the chrysalis shell, for while examining a chrysalis, the moth emerged. By a few sudden jerks of the head, but more especially by friction

*See *Variation of Animals and Plants, etc.*, II, pp. 157–8, English Edition, and the references there given in the foot-note.

with the knees of the middle pair of legs, it severed and ruptured the thin chrysalis shell, and the very moment the anus touched the ruptured end, the creamy fluid usually voided by newly-hatched moths was discharged.

I have never found any parasite attacking this species, but its solitary habit and large size make it a conspicuous object, and it is easily controlled by hand, whenever it becomes unduly numerous upon the Grape-vine.

THE SATELLITE SPHINX—*Philampelus satellitia*, Linn.*

(Lepidoptera Sphingidæ.)

Like the preceding insect this one occurs in almost every State in the Union. It also bears a strong resemblance to the Achemon Sphinx, and likewise feeds upon the *Ampelopsis* as well as upon the Grape-vine; but the worm may readily be distinguished from the former by having five cream-colored spots each side, instead of six, and by the spots themselves being less scalloped.

[Fig. 52.]

In the latitude of St. Louis, this worm is found full grown throughout the month of September, and a few specimens may even be found as late as the last of October. The eggs of this species, as of all other Hawk-moths (*Sphinx* family) known to me, are glued singly to the leaf of the plant which is to furnish the future worm with food. When first hatched, and for sometime afterwards, the larva is green, with a tinge of pink along the sides, and with an immensely long straight pink horn at the tail. This horn soon begins to shorten, and finally

*The synonyms for this insect are *Sphinx lycaon*, Cramer; *Pholus lycaon*, Huebner, and *Daphni pandorus*, Huebner. Mr. A. Grote (Proc. Ent. Soc. Phil., I, p. 60), believes that the *Sphinx lycaon* of the authors above quoted, is distinct from *S. Satellitia*, Linn., and would fain "*eliminate*" a third species (*posticatus*). For reasons which it would be tedious to give here, I prefer to regard *lycaon* as a variety of *satellitia*.

curls round like a dog's tail, as at Figure 52, *c*. As the worm grows older it changes to a reddish-brown, and by the third moult it entirely loses the caudal horn.

When full grown, it measures nearly four inches in length, and when crawling, appears as at Figure 52, *a*. It crawls by a series of sudden jerks, and will often fling its head savagely from side to side when alarmed. Dr. Morris* describes the mature larva as being green, with six side patches; but though I have happened across many specimens of this worm during the last seven years, I never once found one that was green after the third moult; nor do I believe that there are ever any more than five full-sized yellow spots each side, even in the young individuals. The specimen from which the above figure was made, occurred in 1867, at Hermann, Missouri, in Mr. Geo. Husmann's vineyard. The back was pinkish, inclining to flesh-color; the sides gradually became darker and darker, and the five patches on segments 6—10 inclusive, were cream-yellow with a black annulation, and shaped as in the figure. On segments 2, 3, 4, 5 and 6, were numerous small black dots, but on each of the following five segments there were but two such dots. A pale longitudinal line ran above the yellow patches, and the head and first joint were uniformly dull reddish-brown.

The most common general color of the full-grown worm is a rich velvety vinous-brown. When at rest, it draws back the fore part of the body, and retracts the head and first two joints into the third (see Fig. 52, *b*), and in this motionless position it no doubt manages to

[Fig. 53.]

escape from the clutches of many a hungry insectivorous bird. Dr. Morris, copying perhaps after Harris, erroneously states that the three anterior joints, together with the head, are retracted into the *fourth*, and Mr. J. A. Lintner† makes the same false assertion. It is

*Synopsis of N. A. *Lepidoptera,* p. 178.
†Proc. Ent. Soc. Phil., III, p. 659.

the *third* segment in this species, as well as in the Achemon Sphinx, which is so much swollen, and into which the head and first two segments are retracted.

When about to transform, the larva of our Satellite Sphinx enters a short distance into the ground, and soon works off its caterpillar-skin and becomes a chrysalis of a deep chestnut-brown, and very much of the same form as that of the Achemon Sphinx, figured on page 74. The moth (Fig. 53), makes its appearance in June of the following year, though it has been known to issue the same year that it had existed as larva. In this last event, it doubtless becomes barren, like others under similar circumstances, as was shown on page 75. The colors of the moth are light olive-gray, variegated as in the figure with dark olive-green. The worms are easily subdued by hand-picking.

THE ABBOT SPHINX—*Thyreus Abbotii*, Swainson.

(Lepidoptera, Sphingidæ.)

[Fig. 54.]

This is another of the large Grape-feeding insects, occurring on the cultivated and indigenous vines and on the Virginia Creeper, and having in the full-grown larva state, a polished tubercle instead of a horn at the tail. Its habitat is given by Dr. Clemens, as New York, Pennsylvania, Georgia, Massachusetts, and Ohio; but though not so common as the Sphinx moths previously described, yet it is often met with both in Illinois and Missouri. The larva which is represented in the upper part of Figure 54, varies considerably in appearance. Indeed, the ground-color seems to depend in a measure on the sex, for Dr. Morris describes this larva as reddish-brown with numerous patches of light-green, and expressly states that the *female* is of a uniform reddish-brown, with an interrupted dark brown dorsal line and transverse striæ. I have reared two individuals which came to their growth about the last of July, at which time they were both without a vestige of green. The ground-color was dirty yellowish, especially at the sides. Each segment was marked transversely with six or seven slightly impressed fine black lines, and longitudinally with wider non-impressed dark brown patches, alternating with each other, and giving the worm a checkered appearance. These patches become more dense along the subdorsal region, where they form two irregular dark lines, which on the thoracic segments become single, with a similar line between them. There was also a dark stigmatal line with a lighter shade above it, and a dark stripe running obliquely downwards from the posterior to the anterior portion of each segment. The belly was yellow with a tinge of pink between the prolegs, and the shiny tubercle at the tail was black, with a yellowish ring around the base. The head, which is characteristically marked, and by which this worm can always be distinguished from its allies—no matter what the ground-color of the body may be—is slightly roughened and dark, with a lighter broad band each side, and a central mark down the middle which often takes the form of an x. This worm does not assume the common Sphinx attitude of holding up the head, but rests stretched at full length, though if disturbed it will throw its head from side to side, thereby producing a crepitating noise.

The chrysalis is formed in a superficial cell on the ground; its surface is black and roughened by confluent punctures, but between the joints it is smooth and inclines to brown; the head-case is broad and rounded, and the tongue-case is level with the breast; the tail terminates in a rough flattened wedge-shaped point, which gives out two extremely small thorns from the end.

The moth (Fig. 54, below) appears in the following March or April, there being but one brood each year. It is of a dull chocolate or grayish-brown color, the front wings becoming lighter beyond the middle, and being variegated with dark brown as in the figure; the hind wings are sulphur-yellow, with a broad dark brown border breaking into a series of short lines on a flesh-colored ground, near the body. The wings are deeply scalloped, especially the front ones, and the body is furnished with lateral tufts. When at rest, the abdomen is curiously curved up in the air.

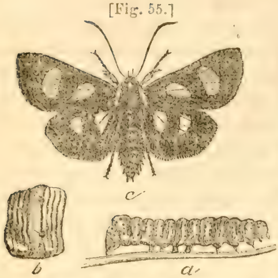
THE BLUE CATERPILLARS OF THE VINE.

Besides these large Sphinx caterpillars, every grape-grower must have observed certain so-called "Blue Caterpillars," which, though far from being uncommon, are yet very rarely sufficiently numerous to cause alarm, though in some few cases they have been known to strip certain vines. There are three distinct species of these blue caterpillars, which bear a sufficiently close resemblance to one another, to cause them to be easily confounded. The first and by far the most common with us is the larva of

THE EIGHT-SPOTTED FORESTER—*Alypia octomaculata*, Fabr.

(Lepidoptera, Zygænidæ.)

[Fig. 55.]



At Plate I, Figure 18 of my First Report, the male of this moth is illustrated by the side of its supposed larva, Figure 19 of the same Plate. In the text (pp. 136–7) I expressed some doubts as to whether this last was the rightful larva of the Eight-spotted Forester, and as I have since reared several moths from the larva state, and ascertained that the worm there figured does not belong to the Eight-spotted Forester, but in all probability to the Pearl Wood Nymph, I will now give the characters of these three different blue caterpillars, so that they may readily be distinguished hereafter.

The larva of the Eight-spotted Forester may often be found in the latitude of St. Louis as early as the beginning of May, and more abundantly in June, while scattering individuals (probably of a second brood) are even met with, but half-grown, in the month of September. The young larvæ are whitish with brown transverse lines, the colors not contrasting so strongly as in the full-grown specimens, though the black spots are more conspicuous. They feed beneath the leaves and can let themselves down by a web. The full grown larva often conceals itself within a folded leaf. It is of the form of Figure 55, *a*, and is marked transversely with white and black lines, each segment having about eight light and eight dark ones. The bluish appearance of this caterpillar is owing to an optical phenomenon from the contrast of these white and black stripes. The head and the shield on the first segment are of a shiny bright deep orange color, marked with black dots, and there is a prominent transverse orange-red band, faint on segments 2 and 3; conspicuous on 4 and 11 and uniform in the middle of each of the other segments. In the middle segments of the body each orange band contains eight black conical elevated spots or tubercles, each spot giving rise to a white hair. These spots are arranged as in the enlarged section shown in the engraving (Fig. 55, *b*), namely, four on each side as follows: the upper one on the anterior border of the orange band, the second on its posterior border, the third just above spiracles on its anterior border—each of the three interrupting one of the transverse black lines—and the fourth, which is smaller, just behind the spiracles. The venter is black, slightly variegated with bluish-white, and with the orange band extending on the legless segments. The legs are black, and the false-legs have two black spots on an orange ground, at their outer base; but the characteristic feature, which especially distinguishes it from the other two species, is a lateral white wavy band—

obsolete on the thoracic segments, and most conspicuous on 10 and 11—running just below the spiracles, and interrupted by the transverse orange band.

I quote here Harris's full description of this larva (*Correspondence*, p. 286), as it agrees with mine, except in giving the number of transverse black lines as 6 on each segment, instead of 8, from the fact that he does not include the two which border the orange band, on account of their being interrupted. I have preferred to consider each segment of this worm as 8-banded, to distinguish it more readily from the other two species, which have respectively only six and four. "Length, when at rest, one inch and two-tenths, very pale blue, transversely banded with orange on the middle of each segment, the bands dotted with small black points, producing hairs, and surmounted by black lines, and between each of the bands six transverse black lines. A large, irregular, white spot on the side of the tenth and eleventh segments, and a series of smaller white spots on each of the other segments except the first three. Head orange dotted with black. Legs blackish externally. The full-grown, have a decidedly bluish tinge, entirely owing, however, to an optical phenomenon from the contrast of the white with the transverse black lines. The head is of a pale dirty orange or rusty yellow, with about eight black dots on each side; [about 10 large and 14 small dots in all,] a semicircular plate on the top of the first segment and the anal valves are pale orange dotted with black. There is a transverse series of black dots on the second and third segments, without an orange band. Each of the other segments is transversely banded with orange and dotted with black; the dots being in two alternate rows, and all of them emitting distinct, long whitish hairs. [The anterior dots on the back of segments 4, 5 and 6 and the posterior ones on 11, are considerably larger than the rest]. Between each of the bands there are six slender, continuous, black transverse lines. The points are also connected by interrupted black lines. Legs at base orange, black externally and at tip, except the anal pair which are orange, dotted with black. The large white lateral spot is common to the side of the tenth and eleventh segments. The other lateral white spots are situated immediately behind the bands on the fourth, fifth, sixth, seventh, eighth and ninth segments, the anterior spots being largest; and thence they diminish to the ninth, while again the posterior spot is very large and very distinct. The orange bands are interrupted on the top of the seventh, eighth and ninth segments."

This larva transforms to chysalis within a very slight cocoon formed without silk, upon, or just below the surface of the earth, and issues soon after, as a very beautiful moth of a deep blue-black color, with orange shanks, yellow shoulder-pieces, each of the front wings with two large light yellow spots, and each of the hind wings with two white ones. The illustration (Fig. 55, *c*) represents the female, and the male differs from her in having the wing spots larger, and in having a conspicuous white mark along the top of his narrower abdomen.

I have on one or two occasions known vines to be partly defoliated by this species, but never knew it to be quite so destructive as it is represented in the following communication from Mr. W. V. Andrews, of New York city, which I take from the February (1869) nummer of the *American Naturalist:*

"That a man should desire to raise his own Isabellas is laudable and praiseworthy; and I see no reason why such desire should exist exclusively in the breasts of our bucolic friends. The inhabitants of New York, as a general thing, clearly are of the same opinion, as is evidenced by the number of grape-vines ornamenting the doors and trellis-work of the houses of our citizens; not, of course, in the benighted regions of Wall street, but up-town; say from Sixteenth street northward. A friend of mine residing on Thirty-fourth street, showed me, in March last, a very fine vine, which he calculated would produce him sundry pounds of choice grapes, and in the pride of his heart he invited me to "call along" occasionally, and feast my eyes on the gradual development of the incipient bunches. Thinking that August would be a good month for my visit, I "called along," wondering in my mind whether my friend would, when the time of ripe grapes came, desire me to help myself out of his abundance; or whether he intended to surprise me with a little basket of nice bunches, garnished with crisp, green leaves. The first glance at the grape-vine banished all doubts on this point. There were an abundance of bunches on the vine, in a rather immature condition, of course, but of foliage there was not a trace. Of course I expressed my surprise, though, for certain reasons, I felt none; and asked my friend why he selected a species of vine for shelter, ornament, and use, which produced no foliage. He rebuked my ignorance pretty sharply, and told me that a few weeks before, the vine was covered with leaves; but, for some inexplicable reason, they had all disappeared—eaten, he guessed, by something. He guessed right. There were at least a hundred of the larvæ of *A*, *octomaculata*, the rear guard of a mighty host, wandering about the branches, apparently for the purpose of making sure that no little particle of a leaf was left undevoured. Pretty little things they were, with harmoniously blended colors of black, yellow and blue, but so terribly destructive! I had the curiosity to walk through all the streets to the east of Third avenue, as low as Twenty-third street, and every vine was in the same predicament. If grape leaves, instead of fig leaves, had been in request for making aprons, and one *Alypia* had been in existence at the time, I doubt if in the whole Garden of Eden enough material would have been found to make a garment of decent size. The destruction of the crop for 1868 was complete.

"This was bad. But it was not half so bad as the helpless ignorance which possessed nearly all of the unfortunate owners of vines. Scarcely one that I conversed with had the remotest idea of the cause of the disaster, and when I explained that it was the caterpillar of a beautiful little black moth, with eight whitish-yellow spots on its wings, which had eaten up the foliage, my assertion was received with such a smile of incredulity, as convinced me that there is no use in trying to humbug such very sharp fellows as are the New York grape-growers.

"It is a little remarkable, however, that the destruction was confined to the eastern part of the city. I saw several luxuriant vines on the western side; and across the river at Hoboken, and at Hudson City, not a trace of *A. octomaculata* was discernible.

"The insect, then, is very local in its habits, and it is a day-flyer; and, from these facts, I infer that its ravages may be very materially checked. A little poisoned molasses, exposed in the neighborhood of the vine, would operate on the perfect insect [extremely doubtful]; while a good syringing with *soft soap* and water would bring down the caterpillars effectually."

THE BEAUTIFUL WOOD NYMPH—*Eudryas grata*, Fabr.

(Lepidoptera, Zygænidæ.)

Here is another moth (Fig. 56), surpassing in real beauty, though not in high contrast, the species just described. The front wings are milk-white, broadly bordered and marked, as in the figure, with rusty-brown, the band on the outer margin being shaded on the inner side with olive-green, and marked towards the edge with a slender wavy white line: under surface yellow, with two dusky spots near the middle. The hind wings are nankin-yellow, with a deep brown border, which does not extend to the outer angle, and which also contains a wavy white line: under surface yellow with a single black spot.

[Fig. 56.]

Surely these two moths are as unlike in general appearance as two moths well can be; and yet their caterpillars bear such a close resemblance to each other, and both feed upon the Grape-vine! The larva of the Beautiful Wood Nymph is, in fact, so very similar to that of the Eight-spotted Forester, that it is entirely unnecessary to figure it. It differs more especially from that species by invariably lacking the white patches along the sides, by the hairs arising from the black spots being less conspicuous, and by the hump on the eleventh segment being more prominent. The light parts of the body have really a slight bluish tint, and in specimens which I have found, I have only noticed six transverse black stripes to each segment. This larva, when at rest, depresses the head and raises the third and fourth segments, Sphinx-fashion. It is found on the vines in the central portion of the State as early as May and as late as September, and it devours all portions of the leaf, even to the midrid. It descends to the ground, and without making any cocoon, transforms to a chrysalis, which is dark colored, rough, with the tip of the abdomen obtusely conical, ending in four tubercles, the pair above, long and truncate, those below broad and short (Packard). Some of them give out the moth the same summer, but most of them pass the winter and do not issue as moths till the following spring.

THE PEARL WOOD NYMPH—*Eudryas unio*, Huebner.

(Lepidoptera, Zygænidæ.)

This is another pretty little moth, so closely allied to, and so much resembling the preceding species, that it is not necessary to produce its picture. It is a smaller species, and differs from the Beautiful Wood Nymph in having the outer border of the front wings paler and of a tawny color, with the inner edge wavy instead of straight;

and in that of the hind wings being less distinct, more double, and extending to the outer angle.

The larva is said by Dr. Fitch to so much resemble that of the preceding species that "we as yet know not whether there are any marks whereby they can be distinguished from each other." (Report 3, § 124.) The moth is more common with us than its larger ally, and though I have never bred it from the larva, yet I have often met with a worm (Fig 57, *a*,) which there is every reason to believe, belongs to this species,

[Fig. 57.]

and which is easily recognized from the preceding. It never grows to be quite so large as the other, and may readily be distinguished by its more decided bluish cast; by having but four light and four dark stripes to each segment (Fig. 57, *b*,); by having no orange band across the middle segments, and by the spots, with the exception of two on the back placed in the middle light band, being almost obsolete. The head, shield on the 1st segment, hump on the 11th, and a band on the 12th, are orange, spotted with black, the hump being marked as at Figure 57, *c*. Venter orange, becoming dusky towards head; feet and legs also orange, with blackish extremities, and with spots on their outside at base.

The worm works for the most part in the terminal buds of the vine, drawing the leaves together by a weak silken thread, and cankering them. It forms a simple earthen cocoon, or frequently bores into a piece of old wood, and changes to chrysalis, which averages but 0.36 inch in length; this chrysalis is reddish-brown, covered on the back with rows of very minute teeth, with the tip of the abdomen truncated, and terminating above in a thick blunt spine each side.

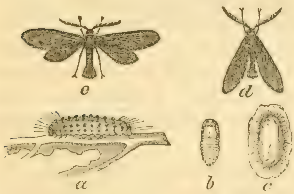
From the above accounts it is hoped that the reader will have no difficulty in distinguishing between these three blue caterpillars of the Grape-vine. But, says the practical grape-grower, "what does it concern me to know whether the little blue varmints that are defoliating my vines, belong to this species or to that? All I wish to know is how to get rid of them, and as they are all three so nearly alike, the remedy applied to one must be equally effectual with the others." Gently, dear reader; it *may* prove of considerable importance that you know which particular species infests your vines! If, for instance, a person living in the West should find the larvæ of the Beautiful Wood Nymph, then he need feel no alarm; while if a person living in the East should find that of the Pearl Wood Nymph, he may in like manner put his hands in his pockets and go his way with an easy mind; for neither of these species are likely to become troublesome in those respective sections of the country, since heretofore they have always been quite rare in those parts. Again, the larvæ of the two Wood Nymphs have a fondness for boring into old pieces of wood, to transform to the chrysalis state, and Mr. T. B. Ashton, of White Creek, New York, found that they would even bore into corn cobs for this purpose in preference to entering the ground, wherever such cobs were accessible.* The Eight-spotted Forester, on the contrary, has no such habit, and while the only mode of combating it, is to pick the larvæ off and burn them, the Wood Nymphs may be more easily subdued by scattering a few corn cobs under the vines in the summer, to be raked up and burned in the winter.

THE AMERICAN PROCRIS—*Procris* [*Acoloithus*] *Americana*† Boisd.

(Lepidoptera, Ctenuchidæ.)

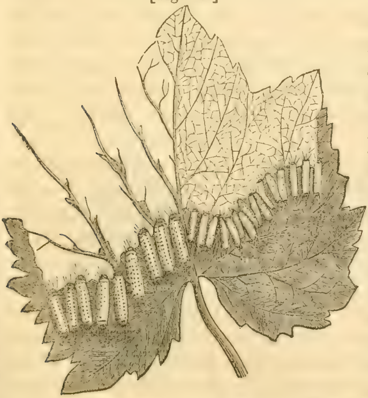
During the months of July and August, the leaves of the Grapevine may often be found denuded of their softer parts, with nothing but the veins, and sometimes only a few of the larger ribs left skeleton-like, to tell of the mischief that has been done. Very frequently, only portions of the leaf will be thus denuded, and in that event, if we examine such a leaf closely, we shall find the authors of the mischief drawn up in line upon the yet leafy tissue with their heads all towards the margin, cutting away with their little jaws and retreating as they feed.

[Fig. 58.]



These little soldier-like files are formed by worms in black and yellow uniforms which produce a moth popularly known as the American Procris. The eggs from which they hatch, are laid in small clusters on the underside of the leaves, and while the worms are small, they leave untouched the most delicate veins of the leaf, which then presents a delicate net-work appearance as shown at the right of Figure 59; but when they become older and stronger they devour all but the larger ribs, as at the left of the figure.

[Fig. 59.]



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*Fitch's Rep. III, p. 82.

†This is the *Aglaope Americana* of Clemens, *Procris Americana* of Boisduval and Harris, and *Ctenucha Americana* of Walker.

The full grown larva (Figure 58, *a*) measures rather more than half an inch, and tapers a little towards each end. It is of a sulphur-yellow color, with a transverse row of six velvety-black, prickly tufts on each of the principle segments, the lower tufts being less distinct than those on the back. The first segment is entirely black with a yellow edge, while the spots on segments 11 and 12 usually run into one another. Head small, brown, and retractile, being usually hidden in the first segment. Fine scattering hairs anteriorly, laterally and posteriorly. The young worm is of a very pale yellow, covered with numerous fine white hairs, with a slight grayish-brown tint on the head, and with the fifth and seventh segments paler than the rest, and having the black spots scarcely visible.

When full grown these worms disperse over the vines or forsake them entirely, and each spins for itself a small, tough, whitish, flattened cocoon (Fig. 58, *c*) within which, in about three days, it changes to a chrysalis (Fig. 58, *b*), 0.30 inch long, broad, flattened and of a light shiny yellowish-brown color. In about ten days afterwards the moths (Fig. 58, *e* and *d*) begin to issue. This little moth is the American representative of the European *Procris vitis;* it is wholly of a black color, except the collar, which is of a deep orange, and the body ends in a broad fan-like notched tuft, especially in the male. The wings are of a delicate texture, reminding one of crape, and when the insect is at rest they generally form a perfect cross with the body, the hind wings being completely hidden by the front ones, which are stretched out straight at right angles, as in the genus *Pterophorus*, to which belongs the Grape-vine Plume.* I have, however, on one or two occasions found the American Procris resting in the manner shown at Figure 58, *d*.

This is the only Grape-vine feeding caterpillar which has a gregarious habit, and as gregarious insects are always more easily subdued than those of a solitary nature, the American Procris need never become very destructive. Its natural food is undoubtedly the wild grape-vines of our forests, and the Virginia Creeper, and Mr. Jordon, of St. Louis, has noticed that while it very commonly attacks the foliage of the Concord, yet it never touches the Clinton and Taylor in his vineyard—a taste which is remarkable and not easily accounted for, since the foliage of the latter kinds is more tender and generally more subject to insect depredations than that of the former.

There are two broods of this insect each year with us, some of the moths from the second brood of worms issuing in the fall, but the greater part not leaving their cocoons till the following summer. During the month of June they may be seen in pairs about the vines, and I have also frequently observed around Hermann, a very closely allied but smaller and different moth (*Acoloithus falsarius*, Clem.) about the same season of the year. This last, though so closely resembling the other, may be distinguished by being scarcely more than half as large; by the body lacking the anal tuft and being comparatively much thicker and shorter; by the hind wings being comparatively larger, and by the collar being of a paler orange and divided on the top by a black point.

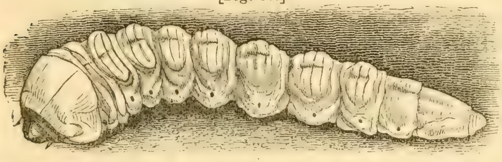
*First Rep., Pl. II, Fig. 15.

The American Procris, though the fact is not mentioned by other authors, is subject to the attack of at least one parasite, with us; for I have bred from it a very peculiar little four-winged black fly belonging to the great *Chalcis* family, and which Mr. Cresson of Philadelphia refers doubtingly to *Perilampus platygaster*, Say.

THE NEW GRAPE-ROOT BORER.

Under this head I published last year* an account of a gigantic Grape-root borer which had at that time not been bred, and of which, in consequence, the perfect insect was not with certainly known. In

[Fig. 60.]



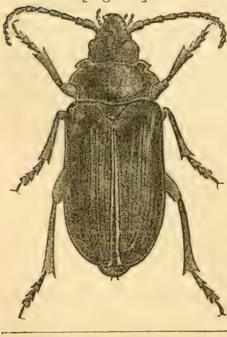
order that the reader may get well familiarized with its appearance, the figure is here reproduced (Fig. 60). For reasons then given I inferred that this borer belonged to the *Prionus* family of the Long-horned beetles, and that it would perhaps produce the Cylindrical Orthosoma (*Orthosoma cylindricum*, Fabr.), a large flattened bay-colored beetle which is common throughout the country, and especially so in the Mississippi Valley, and which I illustrated at the time. I expressed the hope to be able another year to settle this matter, and am glad to be able to do so.

Last July I bred from worms that had been sent to me the year before, as occurring in Grape root, a different, though very closely allied species to that which I had inferred they would produce, namely,

THE BROAD-NECKED PRIONUS—*Prionus laticollis*, Drury.

(Coleoptera, Prionidæ.)

[Fig. 61.]

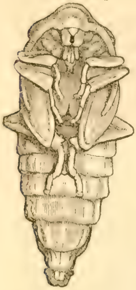


This species is usually of a darker color than the Cylindrical Orthosoma, and differs materially from that species by its larger size and broader form. The female, which is represented at Figure 61, differs from the male in having shorter and narrower antennæ, though her body is usually larger.

In all probability this insect lives nearly three years in the larva state, for three distinct sizes may be found. Those I have bred, left the roots they were inhabiting when about to become pupæ, and formed for themselves smooth oval chambers in the earth wherein they eventually cast their larval skins, and

*First Rep., pp. 124–8.

[Fig. 62.]



assumed the pupa form represented at Figure 62, but in all probability they transform within the root, when in more natural conditions. This change takes place towards the end of June, and the perfect beetle appears in about three weeks afterwards.

Soon after breeding this beetle from Grape-feeding borers, I bred a female of the same species from a very large borer which I had found the same spring, in an apple root, it having entirely killed a young apple tree, by hollowing out nearly all the roots, and by finally severing the tap root near the butt of the tree.

Thus it results that the Broad-necked Prionus bores in the larva state indiscriminately in the roots of the Grape-vine and Apple, and perhaps in those of the closely allied Pear. According to Harris it also infests the roots of different kinds of poplars, and it is consequently a pretty general feeder.

Few persons are really aware of the amount of damage these gigantic borers are capable of causing. Last March I received a long letter from Mr. Robert S. Munford, of Munfordsville, Ky., minutely describing this borer, and the manner in which it destroyed three hundred dollars' worth of his apple trees; while Mr. C. R. Edwards, of Bowling Green, Ky., writes that they have been quite injurious to his grape-vines of all varieties, though his Ionas suffered most from their attacks. Mr. Emory S. Foster, of Bushburg, sent me a specimen in May with the statement that it cut off a vine, after the fall of the leaf, and then went some six inches further down, and entered the main root, making for itself a comfortable residence where it spent the winter. Messrs. Bush and Spaulding inform me that they are continually losing vines from this borer, and that they consider it one of the worst enemies they have to contend against.

Little can be done to prevent the ravages of these underground borers after they are once in a vine, the death of which is usually the only manifestation of their presence. Still, every vine-grower should make it a rule to search for them whenever he finds vines suddenly dying from any unknown cause, and upon finding such a borer should at once put an end to its existence. The beetles, which may often be found during the summer and fall months, and which not unfrequently rush with heavy, noisy flight, into our lighted rooms, should also be ruthlessly sacrificed whenever met with. As I shall presently show, however, much may be done by judicious management to prevent their getting into the vines.

THE TILE-HORNED PRIONUS—*Prionus imbricornis*, Linn.

(Coleoptera Prionidæ.)

There is another species, the Tile-horned Prionus (*Prionus imbricornis*, Linn., Fig. 63 ♂)—so called from the joints of the male antennæ lapping over one another like the tiles or shingles of a roof—which very closely resembles the Broad-necked Prionus, and is with us much commoner. It may be distinguished at once from this last by the antennæ of the male being about 19-jointed, and those of the female about 16-jointed;* whereas both sexes of the Broad-necked Prionus have 12-jointed antennæ. In other respects, these two beetles are almost exactly alike, so that, if the antennæ happen to be broken, it is not very easy to tell one from another.

[Fig. 63.]

♂

Hitherto it has not been known upon what kind of tree this species fed, but I was fortunate enough last summer to ascertain that it also infests grape-roots. On the first of July last, Mr. Isidor Bush, of Bushburg, brought me quite a number of full-grown larvæ which he had taken from the roots of his grape vines. These were so very similar in appearance to those which produced the Broad-necked species, that I had not a suspicion they would produce anything else, and I was consequently greatly surprised when I bred from them a number of the Tile-horned species under consideration. By collecting together fibres and chips of the roots, they form a loose sort of cocoon, and transform, either inside or outside of the root, to pupæ, which resemble so closely that shown in Figure 62, that they can scarcely be distinguished from it.

We have, therefore, two distinct insects which bore into the roots of the Grape-vine, and which, though distinct, are so closely allied, that the females can only be distinguished by the number of joints in their antennæ. One of these is known to attack, besides the Grape, the Apple, the Lombardy poplar and the Balm of Gilead, and the other is very likely equally indifferent as to its choice of diet.

The accounts given in my former article, of the immense borers found in Osage Orange roots, and even in the roots of corn-stalks, undoubtedly refer to one or the other of these insects, and probably to the Tile-horned species, as that is the most common.

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* Having examined nearly 20 males of this species, I have found the antennal joints to vary in number from 18 to 20, the same specimen often having a different number of joints in the right and left antenna. In one ♀ the antennæ are both of them 16-jointed, in another ♀ they are both of them 17-jointed. The typical number of joints in the Coleopterous antenna is only 11; and the number being so variable in these many-jointed antennæ is in accordance with the general rule, hat multiple parts are often variable.

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Several persons who have recognized this immense borer from the figure and description which I published last year, have informed me that they have found it on prairie land, and Mr. Wm. C. Holmes, nurseryman, of Plattsburg, writes: "The Borer described on page 124 of your Report is destroying a good many of our apple grafts, set last spring. The root not being large enough for them to work inside, they eat out about one-third of the bark, and hollow out the rest of the root. Our nursery is on prairie, broke in the fall of 1867 and spring of 1868." Now the fact of these large root-feeding borers occurring in such numbers in recently turned-up prairie land where no large roots exist, would have been perfectly inexplicable had I not been cognizant of other facts which threw light on the subject.

There is a small dimorphous male form of the Tile-horned Prionus not more than half the normal size, and of a much paler yellowish color, which is quite common in the West, and which I have found even more common around St. Louis, than the true type. I know that this form is often found in prairie regions, and my entomological friend Chas. Sonne, of Chicago, Illinois, informs me that a relation of his, Mr. F. Jæger, of Siegel, Illinois, in digging a cellar, once found immense numbers of these large grubs near the surface of the ground. A whole lot of them were sent to Mr. Sonne, and he bred from them numerous specimens of this small form of the Tile-horned Prionus, every one of them males, and every one with nineteen joints to the antennæ. On another occasion, at the same place, Mr. Sonne, having placed a lamp on a grind-stone, found that these beetles swarmed around the light, and next day upon examining a number which he captured, they all proved to be, in like manner, the small yellow form, and all males. Now, Mr. Jæger's house is remote from any timber whatever, there being but a few scrub willows here and there near by; and, from these facts, and those mentioned by Mr. Holmes, we are forced to the belief that these grubs (at least those of the small ♂ dimorphous form) are able, not only to subsist on the roots of small shrubs and very young trees, but also upon those of herbaceous plants. Mr. H. A. Mungor, of Lone Cedar, Martin county, Minnesota, has had a similar experience; for he often ploughs up these grubs in prairie land, and has captured the beetles a full mile away from any trees or shrubs, except a few specimens of a suffruticose plant known as the Lead-plant (*Amorpha Canescens*), which very seldom grows a root there, of over one-half inch diameter. He has also actually bred the beetle from pupæ found in such prairie ground. Therefore, some of the accounts—such as their occurring full grown in the roots of annuals like corn and cabbage, and in those of grape-vines but one year planted—which were not easily explained before; become perfectly clear, now that we have a better understanding of the facts in the case.

Now then comes the point of practical importance. It may with reason be argued, that it matters little to the Grape-grower to which particular species these borers belong, so they have the habit in common, of infesting the roots of his vines. But a more important question presents itself to the thinking mind. Is any danger to be apprehended from these borers, from growing grape-vines and fruit trees among decaying oak stumps? In my former article, from the testimony of practical vineyardists, I have hinted that there is, and have advised not to plant on land covered with such stumps, or even to use oak stakes, where those made of cedar can be had; and I am glad to be able to say that this advice is well founded.

As a general rule, the larvæ of the Long-horned Boring Beetles either inhabit green and living wood or else decaying and dead wood, the same species never attacking both kinds of wood indiscriminately; and as I knew that the larva of the Cylindrical Orthosoma fed on rotten pine wood, I thought it very probable that it also fed on rotten oak stumps, and had been confounded by practical men with those of the Broad-necked and Tile-horned species, which it so much resembles. This opinion was supported by the fact that it occurred abundantly in Union county, South Illinois, in 1861, where there are no pine trees growing, and where, at that period, the so called "poplar" or white-wood was universally used in buildings, in place of pine imported from the North; and I last summer ascertained that it really does breed in rotten oak stumps, as well as in decaying pine, for I found it in the former wood, both in the larva, pupa, and fresh beetle state. But what is still more important I also find that the Broad-necked Prionus, is an exception to the rule above mentioned, and that it breeds as freely in decaying oak stumps as in living roots. For this fact I am indebted to Mrs. Mary Treat of Vineland, N. J., who has sent me specimens of the beetle bred from larvæ that are found abundant in the oak stumps in that vicinity.

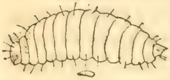
SUMMARY.—To sum up the whole matter in a few words, it is obvious that we have in Missouri three large boring grubs, which so closely resemble each other, that they cannot be distinguished by any marks which we are yet acquainted with—that the Broad-necked Prionus feeds indiscriminately on the living roots of Apple, Grape-vine, Poplar (and perhaps of several other trees), and on decaying oak stumps, and will travel through the ground from one place to another—that the Tile-horned Prionus not only attacks the Grape-vine, but can subsist on the roots of herbaceous plants, and in all probability will also feed on decaying oak, like the former species; and finally, that the Cylindrical Orthosoma feeds on decaying pine and oak, but has not yet been found in living roots. From these facts we may deduce the important corollary, that it will not do to leave oak stumps to rot on ground which is intended for a vineyard or orchard—which was the thing to be proved.

THE GRAPE SEED-MAGGOT—*Isosoma vitis*, Saunders.

(Hymenoptera, Chalcididæ.)

In my First Report (pp. 125–31), I gave an account of a minute maggot (Fig. 64) which had been found by Mr. Wm. Saunders, of London, C. W., to infest the seeds of growing grapes, and to occasion much damage around London and Paris, by causing the berries of the Clinton, Delaware, Rogers' No. 4, and some of Mr. Arnold's Seedlings, to shrivel up without maturing. There are so many noxious insects, common in Missouri, that occur also in the southern portions of Canada West, that it was deemed necessary to give the grape-growers of the State a diagnosis of its work, in case it should at any day make its appearance in our vineyards.

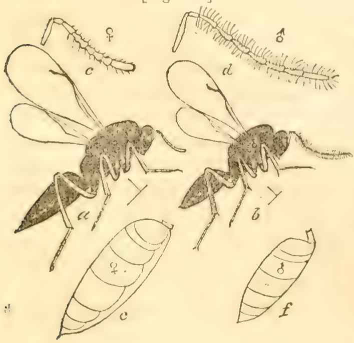
[Fig. 64.]



From the appearance of this maggot, I inferred, with every one else who gave an opinion, that it would most likely produce some small species of snout-beetle (*Curculio* family). Now mark how dangerous a thing it is, for even an entomologist to guess at the character of some insects, when in this masked form. We flatter ourselves that there are but very few insects among the half million different species that are estimated to exist in the whole extent of this terrestrial globe of ours, that we cannot place at a glance in its proper Order, even when in the larva state; but let us humbly acknowledge that there are some few larval forms among the more minute Four-winged Flies (order *Hymenoptera*) and Beetles (order *Coleoptera*) which it is almost, if not absolutely, impossible to distinguish the one from the other.

Last August I had the pleasure of spending a few hours with Mr. Saunders, at his place in London, and I was gratified to learn that he had bred the perfect insect from this seed-maggot. It proved to be a little Four-winged fly (*Chalcis* family), and upon my return home, I found a few specimens of the very same species of fly, in a bottle in which were placed some infested grapes received the year before from Mr. A. S. Fuller of New Jersey, and obtained by him from Canada.

[Fig. 65.]



This fly so closely resembles the notorious Joint-worm Fly (*Isosoma hordei*, Harris) that the accompanying highly magnified sketch (Fig. 65) of that insect—*a* representing the female, *b* the male, *c* the ♀ antenna, *d* the ♂ do., *e* the ♀ abdomen and *f* the ♂ do.—will afford a very correct idea of its appearance.

The Grape Seed-maggot Fly differs principally from the Joint-worm Fly in its somewhat smaller size, in the legs being marked with black on the thighs and shanks, in the ♂ abdomen being comparatively shorter, and in its third ring conspicuously overhanging the fourth. The following account and description from Mr. Saunders himself, is taken from the November number of the *Canadian Entomologist:*

"In October I detached a larva from the inside of the seed, and placed it in a small glass cell between two plates of glass, in which state it remained until early in January, when it became a pupa, having first attached itself to the sides of the cell by a few short silky threads. It had now contracted in length, become nearly oval, and assumed a yellowish tint, with a few short loose silky threads adhering to different parts of its surface. On the 11th of February I examined some seeds and found the larva within, still alive and active, just as it appeared in the fall. On the 7th of July further specimens were opened and the inmates found soft and motionless; these appeared to be in the pupa state, but I did not examine them with sufficient care to enable me to be positive. During the remaining part of July, I looked many times into the bottles in which the grapes were enclosed but could not discover anything. On the 9th of August, feeling sure that the time for the appearance of the insect must be fully come, if not already past, I resolved on a thorough search for it. As soon as the contents of the bottles had been emptied on a piece of white paper, I observed a number of small four-winged flies among the dried-up grapes. They were all dead and stiff, some of them more brittle than others. From the observations made, I should judge that they made their escape from the middle to the end of July."

ISOSOMA VITIS, Saunders, ♀—*Head* large, flattened in front, black, thickly punctured, and covered with many short whitish hairs; mandibles pale brown at base, tipped with black; antennæ (scape and 8 joints), 9-jointed, black, thickly covered with whitish hairs inserted in deep sockets; the scape pale brown, slender, nearly as long as the three following joints together; the second short; third to eighth inclusive nearly equal in length; the terminal joint longer, tapering slightly towards the tip. *Thorax* black, punctured and covered with whitish hairs. *Legs*, front pair pale brown, trochanters nearly black; second and third pairs, trochanters black, femora and tibiæ nearly black along the middle, pale brown at tips; tarsi pale brown. *Abdomen*, long, black, straight, smooth, with a polished surface; placed on a short pedicel; a little contracted at base, thickest on third joint, tapering gradually to fifth, and then suddenly to extremity; the basal joint very short, second and third each somewhat longer, fourth as long as the three preceding, fifth less than half as long as fourth, sixth a little shorter, terminal joint rather longer.

♂ differs from ♀ in having the antennæ somewhat longer and more thickly covered with hairs. His abdomen is short, thick and blunt, placed on a moderately stout pedicel nearly its own length. The abdominal rings have about the same relative size as in the female, but the posterior edge of third overhangs the fourth, the latter appearing as if partially drawn within the projecting edge of the third ring.

Length ♀ 0.10, ♂, 0.06 inch.

"Having kept the grapes in bottles, only occasionally opened for ventilation, in a dry room, they had become quite hard, dry and shrivelled. In consequence of this, many of the flies were unable to make their way out, the seed having become too hard for their jaws to eat through. On opening some of these the flies were found dead with wings fully developed and surrounded by small fragments of the interior coating of the seed which they had evidently gnawed off while endeavoring to escape. Those which had found their way out had eaten a small nearly round irregular hole through seed and skin. In many similar cases where the larva feeds within a hard substance it provides for the escape of the perfect insect by eating away the hard enclosure until it is reduced so thin as to appear almost transparent, then a very little effort is sufficient to remove the obstruction to the outward passage of the imago. In this instance I have been unable to detect any such preparation, and believe that the whole work of escape is accomplished by the perfect fly.

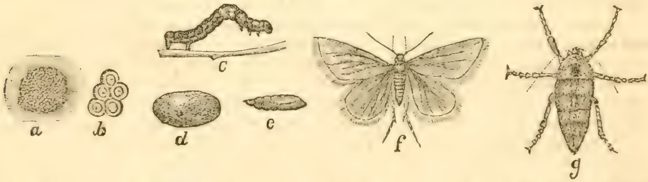
"Notwithstanding the abundance of this insect last year, I have as yet been unable to detect their presence or any evidence of their work during the present season; probably the cold and wet character of the summer has been unfavorable to their operations."

THE CANKER-WORM—*Anisopteryx vernata*, Peck.

[Lepidoptera Phalænidæ.]

This word CANKER-WORM has formed the heading of so many articles in our various Agricultural and Horticultural journals during the last ten or twelve years, and its natural history has been so fully given in the standard work of Dr. Harris, that one almost wonders

[Fig. 66.]



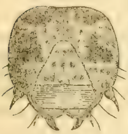
where there can be a reading farmer who does not know how properly to fight it. But then, new generations are ever replacing those which pass away, so that the same stories will doubtless have to be repeated to the end of time. Facts in Nature will always bear repeating, and as it may be laid down as a maxim that no injurious insect can be successfully combated without a thorough knowledge of its habits and transformations, I will first recount those of the Canker-worm, and afterwards state the proper remedy.

The eggs of this insect are very minute, measuring about 0.03 inch in length and 0.02 in diameter. In form they are not unlike a miniature hen's egg, minutely roughened and with longitudinal irregular depressions. They reflect prismatic colors, and are deposited close together in rows, forming batches such as that shown in the above Figure 66, *a* representing them of the natural size, and *b* representing them magnified. They are glued together by a grayish varnish which the mother moth secretes, and they are attached to the trunk, or to some one or other of the twigs of the tree, and may often be found on the inside of loose scales of bark, each batch consisting of upwards of a hundred eggs.

As the leaves begin to form, these eggs hatch into minute, thread-like span-worms, which in from three to four weeks afterwards acquire their full size, when they appear as at Figure 66 *c*. The Canker-worm is distinguished from most other caterpillars that attack the Apple, by having but four prolegs at the end of the body. The normal number of such prolegs in caterpillars, is ten; and it is the lack of the foremost six which obliges our insect to span or loop, from which habit the characteristic name GEOMETRIDÆ has been given to the group to which it belongs.

When full-grown this worm measures scarcely an inch in length, and is commonly ash-gray on the back, darker at the side and yellowish

[Fig. 67.]



beneath. It varies greatly in the intensity of its markings however, ash-gray, green, and yellow ones occurring in the same brood, and the most constant character by which it may be distinguished from other span-worms of the same size, is the pattern of the head, which, no matter what the general hue of the body may be, is usually shaded and marked as in the annexed Figure 67. The markings of the worm vary indeed so much, that, without this criterion I could hardly venture to determine a Canker-worm larva myself.

I subjoin a very full description of this worm from numerous average specimens, as it is of considerable importance, that an orchardist may be able to ascertain definitely whether he is troubled with the true Canker-worm or not. For if he mistakes some other span-worm which produces winged females as well as winged males, for the genuine Canker-worm which is apterous in the female moth state, it becomes very obvious that all his efforts to try and prevent the ravages of the spurious Canker-worm by the most approved and well-tried methods, will not only fail most absolutely, but he will lose all faith in such remedies, and may perchance, if he is given to the use of the quill, vent his wrath and disappointment by sending to some one of the horticultural journals of the land, a pithy article "based upon FACTS [?] and EXPERIENCE" showing up the utter worthlessness of the Canker-worm remedies!

It is from such lack of true knowledge that the City Fathers of Baltimore, Maryland, went to the useless expense of furnishing oil troughs for all their large elm trees which were being defoliated, under the delusive idea that the insect committing the ravage was the Canker-worm; whereas it turned out to be the larva of a little imported Beetle (*Galeruca calmariensis*, Fabr.), the female of which has ample wings, and can fly as readily as a bird from tree to tree; and it is from such oversights, that paragraphs like the following take their rise. This one may be found in the *Boston Journal* for may 23d, 1866:

ORIGIN OF CANKER-WORMS.—A Medford correspondent says that last fall he applied to his trees protectors which were pronounced the best in the neighborhood, and notwithstanding not a single grub passed over them, the trees, like others in the vicinity, are this season covered with worms which are now pursuing their devastating work. In his opinion the Canker-worms do not originate from the grub, and he challenges proof that they do. The subject is one worthy of investigation!

Whe-e-e-e-ou! It needs no comments in this Report.

When first hatched the young Canker-worms are of a dark olive-green or brown hue, with a shiny black head and thoracic legs, with a whitish lateral and dorsal band, the latter having a darker central line along it. After the first moult, the head becomes lighter and mottled, and the light bands less conspicuous. After the second moult the bands are almost obliterated and the body becomes more uniformly mottled and speckled with livid-brown; the head becomes still lighter and the prolegs being now large, spread out at almost a level with the venter. After the third (and I believe last) moult the appearance changes but little. The full grown larva averages 0.90 inch in length with an average diameter of 0.10 inch, being broadest on joint 11. It varies from light fleshy-gray to almost black. Head mottled as in Figure 67. Ends of body somewhat darker than middle. Joint 1 with a yellowish dorsal shield, the hinder margin in form of a rounded W. Viewed under a lens the body has a series of eight fine light yellowish, irregular, somewhat broken lines, running the whole length of the body, each one relieved by a darker shado each side of it. The two along middle of dorsum are close together, with the space between them usually dark, and occupied at anterior edge and middle of joints 5, 6, 7 and 11 by black marks somewhat in form of x, these marks being represented by simple black dots on the other joints. Space between these dorsal lines and the next lowest, lighter, and containing four black piliferous spots to each joint, the posterior ones rather further apart than the anterior ones which on joint 11 form two larger elevated shiny black spots. Space between lines 2 and 3 darker than any other part of the body. That between lines 3 and 4 lighter than any other part of body and containing the stigmata which are perfectly round and black with a light centre, with a small piliferous spot anteriorly above and below them, and another behind them, this last becoming large on joints 5, 6, 7 and 8. Venter dark and livid at borders, with a pale greenish band along the middle, which has a pinkish patch in it on joints 5, 6, 7 and 8. Legs greenish at base, color of body at extremity. The markings are most distinct on the light specimens.

The Canker-worm is by no means confined, in its destructive work, to the Apple, for it likewise attacks the Plum, the Cherry, the Elm, and a variety of other trees. Mr. R. J. Mendenhall, of Minneapolis, Minn., even informs me, in a recent letter, that "the Currant worm" spoken of in a late number of the *Farmer's Union* as infesting the currant bushes in the gardens around that city, were really Canker-worms, but he is most assuredly mistaken. The Canker-worm is seldom ever noticed on our trees till the riddled and seared appearance of the foliage tell of its presence; for, like most other span-worms, it has the habit of resting in a stiff straight posture, either at an angle of about 45° from, or flat and parallel with the twig which it occupies—thus eluding detection.

After it has attained its full size it either crawls down the tree or lets itself down by means of a silken thread, and burrows into the ground. Here, at a depth of two or three inches, it forms a rude cocoon of particles of earth intermixed with silk (Fig. 66, *d*). Within two days after completing the cocoon the worm becomes a chrysalis of a light brown color. The sexes are now distinguishable, the male chrysalis (Fig. 66, *e*) being slender, pointed in front, and showing the wing-sheaths; while that of the female is larger and destitute of wing-sheaths.

In the latitude of St. Louis, the worms have generally descended from the trees and entered the ground by the middle of May, though some remain till about the first of June. As I have amply proved during the past two summers, there is but one brood each year in this State, just as there is but one brood in Maine, and whether the worms enter the ground the first or the last of May, they remain there as chrysalids all through the summer and fall months, and the great majority of them till the following spring. A frost seems to be necessary to their proper development. Some come out during the first mild weather that succeeds the first frosts in November; others issue all through the winter whenever the ground is thawed, and the great bulk issue as soon as the frost is entirely out of the ground in spring. Many which I bred this winter issued during the warm weather of January.

The moths (Fig. 66 *f* ♂, *g* ♀) show great disparity of sex, the male being fully winged while the female is entirely destitute of these appendages. The front wings of the male are pale ash-gray, crossed by three equidistant jagged, more or less defined, black lines, all curved inwardly, and most distinct on the front or costal border; and by a somewhat broader whitish line, which runs from the posterior angle to the apex; the inner and terminal borders also being marked with black. The hind wings are silvery-gray, and the under surfaces are of the same uniform silvery-gray color, each wing with a dusky discal spot, the front wings each with an additional spot on the costa. Such is the appearance of the more common perfect specimens found in the West, but the wings are very thin and silky, and the scales easily rub off, so that it is almost impossible to capture a perfect specimen at large. They vary considerably also—so much so that Dr. Harris ranks a smaller form as a distinct species (*A. pometaria*) which I have however bred promiscuously with the more typical specimens. The most common variation from the brief description above given, is found in such specimens which have the dark lines obsolete, and an additional white line inside the one described. The female is ash-gray, the thorax with a black spot, the body more or less marked with black along the back, and the legs alternately marked with black and white.

In Missouri the Canker-worm is not so injurious over broad tracts of country, as it is in some of the more eastern States. Yet it is sufficiently distributed in different parts, to require vigilance to keep it down. "R. P.," of Mexico, Mo., found it very injurious in the spring of 1868, and sent me many specimens, and they were the genuine article. Around Pevely, I have likewise found it common on the farms of Dr. Varnum and Mr. Foster. Mr. Wm. M. Beal of Edina tells me that it is considered one of the very worst enemies in Knox county, and as I am informed by Mr. J. D. Dopf, editor of the *Journal*, Rockport, Atchison Co., it was exceedingly troublesome to the elms there in 1866. Where they have once become established, and are neglected, their ravages soon become very great; and they were so bad in certain parts of Michigan a few years ago, and especially in the Grand Traverse region in 1865, that, unless my memory fails me. a certain Eastern editor, in response to an appeal for a remedy from Mr. Sanford Howard, the Secretary of the Michigan State Board of Agriculture very foolishly urged the Wolverines to cut down their trees. May I hope that these Entomological Reports will be the means of protecting Missouri from the fearful ravages of this worm which has so often discouraged the orchardists in Massachusetts, Rhode Island, Connecticut, and some of the Middle States.

It is the apterous condition of the female moth which gives us such complete control of this enemy, and which indicates

THE PROPER REMEDY.

The sole object of the female, after she leaves the earth, seems to be to provide for the continuance of her kind, and she instinctively places the precious burden, which is to give birth to the young which she herself is destined never to behold, upon the tree whose leaves are to nourish those young. All her life-energy is centered in the accomplishment of this one object, and she immediately makes for the tree upon issuing from the ground. Consequently, anything that will prevent her ascending the trunk will, in a great measure (but as we shall presently see, not entirely) preserve the tree from the ravages of the worm.

Numerous indeed have been the devices—patented or unpatented—which have at different times and in different parts of the country been used to accomplish this desired end; and every year our Agricultural journals report individual experiments with some one or other of these devices—some favorable and others adverse. Tar, applied either directly around the body of the tree, or on strips of old canvas, on sheep-skin, or on stiff paper; refuse sorghum molasses, printers' ink, or slow-drying varnishes, or melted India rubber, which always retains its soft viscid state, applied in a similar manner; tin, lead, and rubber troughs to contain oil; belts of cotton-wool, etc., etc., have all been used, and with both good and bad results, very much according as they have been used intelligently or otherwise. Now, all these appliances, of whatsoever character, are divisible into two classes: first, those which prevent the ascension of the moth by entangling her feet, and trapping her fast, or by drowning her; and, second, those which accomplish the same end by preventing her from getting a foothold, and thus causing her repeatedly to fall to the ground until she becomes exhausted and dies.

The first class of remedies are thoroughly effectual when applied understandingly and persistently. And by this I mean, that the orchardist must know that many of the moths issue in the fall of the year, and that the applications must, in consequence, be made at least as early as the latter part of October, and that they must be kept sticky, through all but freezing weather, till the leaves have well put out, in the following spring. Furthermore he must know that many of the moths—frustrated in their efforts to climb the tree—will deposit their eggs near the ground or anywhere below the application, and that the young worms hatching from them are able to pass behind the slighest crevice or over the finest straw. Thus, if troughs are used, they must be fitted over a bandage of cotton-wool, so that when the trough is drawn tightly around the tree, it will do no injury, and will at the same time cause the cotton to fill up all inequalities of the bark; the joint must likewise be kept smeared either with tar or molasses, and then the worms will not be able to pass. In the neglect to thus fasten them, lies the secret of failure which many report who use such troughs. The second class of contrivances are of no avail whatever, for although the moth is unable to travel over a very smooth surface, I know from experience that the young worms can march over the smoothest glass by aid of the glutinous silken thread which they are able to spin from the very moment they are born. For these reasons, even the "Merritt's Patent Tree-Protector," which was so well advertised by Mr. Howard in his otherwise excellent article on the Canker-worm, in the Michigan Agricultural Report for 1865, must be classed with the worthless patents. This "Protector" consists of a ring of glass grooved below and hung from the tree by a tent of canvas, to which it is fastened by an iron clamp.

I might enumerate a number of such ingenious contrivances both of glass, wood, tin, and isinglass, for heading off the female moth *only*, and some few which are sufficiently thorough to head off the young larvæ also; but they are all so expensive, that I am perfectly convinced they will never be adopted in our large orchards; nor are they necessary, for some of the remedies already mentioned are altogether more simple and more effectual.

It cannot be denied that it requires a great deal of time, labor and expense to continually renew the applications of tar on every tree in a large orchard during so many months of the year; while its application directly to the bark is more or less injurious to the trees. For these reasons, refuse sorghum molasses will be found much better for the purpose, as it does not harden so rapidly, and is said not to be injurious to the tree. In neighborhoods where sorghum is grown, it is also much cheaper. That it will pay to do this work in orchards where the Canker-worm is known to be numerous, there cannot be the least doubt. The old adage, "What is worth doing at all is worth doing well," was never truer than in fighting this insect, Apply the remedy thoroughly during two successive years, and you have utterly routed the enemy, and this is more especially the case where an orchard is not in too close proximity to the timber, or to slovenly neighbors. Fail to apply the remedy, and the enemy will, in all probability, rout you. The reason is simple. The female being wingless, the insect is very local in its attacks, sometimes swarming in one orchard and being unknown in another which is but a mile away. Thus, after it is once exterminated, a sudden invasion is not to be expected, as in the case of the Tent Caterpillar, and of many other orchard pests; but when it has once obtained a footing in an orchard, it multiplies the more rapidly, for the very reason that it does not spread fast.

If oil troughs are used, it will be found much safer, and surer to sink them in the ground close around the butt of the tree, instead of winding them around the trunk higher up. There will then be no chance for the young worms to get up between the trough and the tree. But it follows, that this plan can only be adopted in an orchard which is kept perfectly clean.

As for muriate of lime, which has been so earnestly recommended as a preventive, by interested parties, here is what Mr. Sanford Howard says of it in the *Western Rural* of August 18th, 1866, and Mr. Joseph Breck, editor of the old American *Journal of Horticulture*; G. C. Brackett, correspondent of the *Maine Farmer*, and several other persons with whom I am acquainted, all testify, after having thoroughly tried it, to its utter worthlessness for this purpose:

The editor of the *Farmer* says, there are statements to the effect, that a substance called Gould's Muriate of Lime, applied to the soil in autumn, had entirely prevented the subsequent appearance of Canker-worms on trees standing on the ground, although the trees had previously been much damaged by the insect. It is also stated that on other trees, not ten rods distant, where none of the so-called muriate of lime was applied, the worms were very destructive.

I cannot think that this amounts to any proof that the substance applied destroyed the worms, or had any effect on them. The non-appearance of the insect in the case alluded to, was probably due to other causes. If this substance will kill or injure the insect in any of its stages, it would be easy to prove it by a direct application to soil containing insects, in a box. Several years ago, I took pains to make a particular experiment with this so-called muriate of lime, the result of which was that the Canker-worm underwent its transformations naturally, and to all appearance healthfully, in a soil composed of nearly fifty per cent. of the articles of which it was said a small proportion only was necessary to totally destroy them? If the substance is the same in composition now that it was then, it is reasonable to suppose that the result of its application would be the same.

As to the "Plug Ugly Theory," which consists of filling an auger bore with sulphur and plugging it tight, and which originated, some years since, in the inventive brain of some *Prairie Farmer* correspondent; it is altogether too absurd to need consideration, for even if the mode of application were not so downright ridiculous, it is well known to entomologists that many caterpillars will thrive exceedingly on leaves that have been thickly sprinkled with sulphur.

Vigilance is the price of reward, and as it is always easier to prevent than to cure, it were well for the owners of young orchards, in neighborhoods where the Canker-worm is known to exist, to keep a sharp look-out for it; so that upon its first appearance the evil may be nipped in the bud. In the same manner that it is exterminated in the individual orchard, in like manner, it may, by concert of action, be exterminated from any given locality. When once the worms are on a tree, a good jarring will suspend them all in mid-air, when the best way to kill them is by swinging a stick above them, which breaks the web, and causes them to fall to the ground; when they may be prevented from ascending the tree, by the methods already described, or by strewing straw on the ground and setting fire to it.

One word in commendation of late fall plowing and the use of hogs. A good deal has been said both for and against fall plowing, and the following discussion which took place at the November (1868) meeting of the Alton (Ills.) Horticultural Society, will afford a sample of the different opinions held by individuals:

Dr. Long took the ground that fall plowing was one of the best and surest means of eradicating those insects which stay in the ground over winter. He said, some five or six years ago my orchard was badly infested with the Canker-worm; by late cultivation, I almost, if not entirely, got rid of them.

Dr. Hull—I do not believe that fall plowing will destroy the larvæ of insects to any extent. I have dug up frozen lumps containing larvæ that were not affected by freezing. I think the Canker-worm will not spread here as in New England.

J. Huggins—I have been led to believe—contrary to Dr. Hull's statement—that they will spread, and feel that there is great danger of their spreading. I believe fall plowing a great aid in the extermination of them. Cites a case where they have been almost entirely destroyed by late plowing, in an orchard that was nearly ruined by them.

Dr. Hull—If it be true that they will spread, why is it that none of Dr. Long's neighbors have them? He says he was badly overrun with them, and the fact that his neighbors were not, I think confirmation of my statement that they will not spread.

Dr. Long—My brother's orchard, adjoining mine, had double as many as my own. He fall plowed, and has very few left. He also cites the case of an old orchard, in this section, that was almost destroyed by them, but fall plowing has almost, if not entirely, destroyed them.

The following item from the New York Weekly *Tribune* of February 26th, 1869, also bears on this point:

Canker-worms Destroyed by Plowing.—Mr. McNeil Witherton, in answer to W. V. Monroe's request: I will state that I think that the Canker-worm can be destroyed by plowing the ground where they are, late in the fall. The 25th of Nov., 1867, I was at my son David's in Wisconsin. He told me that the Canker-worms were in his orchard, and had injured his apple trees very much the past season; that a man who owns a nursery and keeps apple trees for sale, went into the orchard and examined the trees and worms, and said it was the Canker-worm that was injuring his orchard. I told him that about fifty years ago they had been in my father's orchard some six years, and killed a large number of the trees; that we plowed it late in the fall, and have never seen the Canker-worm there since. I advised him to plow his orchard immediately. The next day he plowed it as far as the worms had been in it. I received a letter from him a few weeks ago, stating that the Canker-worms were not in his orchard this year, and those trees that were injured and not killed last year, revived some this year.

Now there is no doubt but late plowing will produce somewhat different effects, according to the character of the soil, and the depth of the plowing; but that it is more generally beneficial than otherwise I am perfectly convinced, and as for the assertion of Mr. Wm. P. Lippincott, of Vernon, Iowa, made some time ago, in the *Iowa Homestead*, namely, that it left the ground full of harbors for the next year's breeding, it suffices to say that the insect does not breed in the ground, and, holes or no holes, the worms will penetrate the soil whenever the time arrives to change to chrysalis. After the summer months the insect invariably lies in the chrysalis state snugly entombed in a little earthen cell very thinly lined with silk, from two to six inches below the surface. This cell, though frail, is a sufficient protection, so long as it is whole, from any excess of moisture, and at the same time prevents too much evaporation in case of summer drouth or dry winter freezing. Now I have proved by experiment that whenever this cell is disturbed or broken in cold weather, the chrysalis has not the power to penetrate the ground again, and in the great majority of instances, either rots, dries out, becomes mouldy, or, if on the surface, is devoured by birds. Even summer plowing, if performed after the first of July would work beneficially; and it is for this reason, that clean, well cultivated orchards are more free from the attacks of this insect, than slovenly and neglected ones. The only advantage of late fall plowing, lies in the facts, that the chrysalis is at that time too benumbed to work itself into the ground and form another cell, and that birds are then harder pushed for food, and more watchful for any such dainty morceau.

As to the efficiency of hogs, in rooting up and devouring the chrysalids, during the summer months, abundant favorable testimony might be cited; but the facts are too obvious to need argument.

ENEMIES OF THE CANKER-WORM.

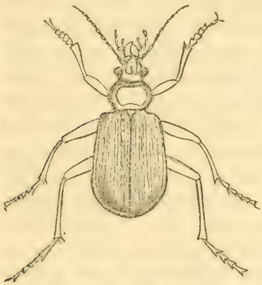
Like most of our noxious insects, the Canker-worm is subject to the attacks of cannibal and parasitic insects. It is also devoured by very many different birds, some of which almost entirely live on it; and Dr. Packard, of Salem, Mass., has observed an elongated mite (*Nothrus ovivorus*, Fig. 68, enlarged) devouring its eggs. The most common parasite which I have yet discovered with us, is an undescribed small four-winged fly belonging to the genus *Microgaster*, of the same size, but differing from the Military Micro-

[Fig. 68.]

gaster (Fig. 23) which preys upon the Army-worm. It differs also from most other insects of the same genus, by each individual larva as it eats through the skin of the Canker-worm, spinning its pale greenish-white cocoon alone, and not in company. About ten per cent. of the worms which I have endeavored to breed, have been destroyed by this parasite. Harris mentions the larva of another four-winged fly, and that of a two-winged fly belonging to the genus *Tachina*, which also infest the worm, destroying about one-third of them in Massachusetts. There is also a very minute and undescribed species of *Platygaster* which pierces the egg of the Canker-worm, and drops one of her own into it, from which in due time the perfect fly develops.

Among the Cannibal insects, which prey upon it, may be mentioned the Ground-beetles, two of which I have found preying upon this worm, namely, the Rummaging Ground-beetle (*Calosoma scrutator*, Fabr. Fig. 69), a large and beautiful insect, with the wing-covers golden-green, and the rest of the body marked with violet-blue, gold, green, and copper; and the Fiery Ground-beetle (*Calosoma calidum*, Fabr. Fig. 70.), a black species of almost equal size, with copper colored spots on the wing-covers. These beetles are very active, and run over the ground in search of soft-bodied worms, and will even mount upon the trunks of trees for the same purpose.

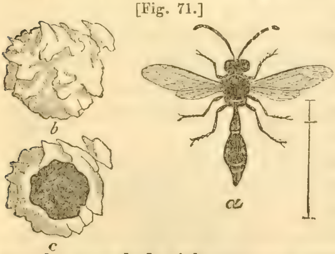
[Fig. 69.]



[Fig. 70.]

The Fraternal Potter-wasp (*Eumenes fraterna*, Say), is stated by Harris, to store her cells with Canker-worms, often gathering eighteen or twenty of them for a single cell. This wasp (Fig. 71, *a*), is quite common in St. Louis county, and uses other species besides Canker-worms as food for its young. Its clay nest (Fig. 71 *b*, entire; *c*, the same cut open shortly after it was built, showing the manner in which it is compactly crowded with green worms), may often be found attached to the stems of the Goldenrod and of other plants in the open air, or cemented under the loose bark of some tree. It has even been found attached to the leaves of a deciduous plant, where it must necessarily fall to the ground in winter and lie there till the perfect insect issues in the following summer.

[Fig. 71.]



CABBAGE WORMS.

Of the various insects that affect this important esculent, the three following are among the most injurious in this State:

THE SOUTHERN CABBAGE BUTTERFLY—*Pieris protodice*, Boisd.

(Lepidoptera, Pieridæ.)

Mr. S. H. Scudder, of the Boston Society of Natural History, from an examination of a large number of specimens of this butterfly, found that it enjoys a wide geographical range, "extending from Texas on the southwest, Missouri on the west, and the mouth of the Red River of the North on the northwest, as far as Connecticut, and the Southern Alantic States on the east."* But while the species is scarce in the more northern States, it is the common white butterfly of Missouri, abounding in many parts of the State, and sometimes flitting so thickly around the truck gardens near large cities, as to remind one at a distance, of the falling of snow. It often proves exceedingly injurious, and I learn from a Mississippi exchange, that "there were last year thousands of dollars' worth of cabbages devastated and ruined by worms in the neighborhood of Corinth." The paragraph goes on to state, "that cabbages could not, in consequence, be had there even at ten cents per head." The "worm" referred to, was doubtless the species under consideration.

[Fig. 72.]

[Fig. 73.]

I have often passed through cabbage beds near St. Louis, and been unable to find a perfect head, though few of the gardeners had any suspicion that the gay butterflies which flitted so lazily from one plant to another, were the real parents of the mischievous worms which so riddled the leaves.

The larva (Fig. 72, *a*) may be summarily described as a soft worm, of a greenish-blue color, with four longitudinal yellow stripes, and covered with black dots. When newly hatched it is of a uniform orange color with a black head, but it becomes dull brown before the first moult, though the longitudinal stripes and black spots are only visible after said moult has taken place.

I subjoin a more complete description of it:

Average length when full grown 1.15 inches. Middle segments largest. Most common ground-color green verging onto blue; sometimes clear pale blue and at others deep indigo or

* See Proc. Bost. Soc. Nat. Hist., VIII, 1861, p. 180.

purplish-blue. Each segment with six transverse wrinkles, of which the first and fourth are somewhat wider than the others. Four longitudinal yellow lines, each equidistant from the other, and each interrupted by a pale blue spot on the aforementioned first and fourth transverse wrinkles. Traces of two additional longitudinal lines below, one on each side immediately above prolegs. On each transverse wrinkle is a row of various sized, round, polished black, slightly raised, piliferous spots; those on wrinkles one and four being largest and most regularly situated. Hairs arising from these spots, stiff and black. Venter rather lighter than ground-color above, and minutely speckled more or less with dull black. Head same color as body; covered with black piliferous spots, and usually with a yellow or orange patch each side—quite variable. The black piliferous spots frequently have a pale blue annulation around the base, especially in the darker specimens.

The chrysalis (Fig. 72, *b*), averages 0.65 inch in length, and is as variable in depth of ground-color, as the larva. The general color is light bluish-gray, more or less intensely speckled with black, with the ridges and prominences edged with buff or with flesh-color, and having larger black dots.

[Fig. 74.]

The female butterfly (Fig. 73) differs remarkably from the male which I represent at Figure 74. It will be seen, upon comparing these figures that the ♀ is altogether darker than the ♂. This sexual difference in appearance is purely colorational, however, and there should not be the difference in the form of the wings which the two figures would indicate, for the hind wings in the ♂ cut, are altogether too short and rounded.

This insect may be found in all its different stages through the months of July, August and September. It hybernates in the chrysalis state. I do not know that it feeds on anything but Cabbage, but I once found a ♂ chrysalis fastened to a stalk of the common nettle (*Solanum carolinense*), which was growing in a cemetery with no cabbages within at least a quarter of a mile: and Mr. J. R. Muhleman is reported as having stated at a late meeting of the Alton (Illinois) Horticultural Society, that it is injurious to turnips and other plants of the cabbage family. There are two broods of this insect each year.

As already stated, in the more northern and eastern States our Southern Cabbage Butterfly occurs in comparatively small numbers, but it is replaced by the Potherb Butterfly (*Pieris oleracea*, Boisd.), an indigenous species which does not occur with us. This last (Fig. 75, butterfly with the larva beneath) is in reality a northern species, for it rarely reaches as far south as Pennsylvania, but extends east to Nova Scotia, west to Lake Superior, and north as far as the Great Slave Lake in the Hudson's Bay Company's territory. It is readily distinguished

[Fig. 75

from our species by being perfectly plain, with no black spots on the wings. The body is black, and the front wings have a slight shade of this color at their base, front edge, and tips. Its larva is pale green

[Fig. 76.]

and feeds on various other cruciferous plants besides cabbages; its chryalis (Fig. 76) is also pale green or whitish, regularly and finely dotted with black.

This butterfly has existed from time immemorial on the American continent, within the geographical limits already given, and yet has never made its way into Missouri or any of the southwestern States. Nor is it likely to ever do so; and why? Because some insects are constitutionally incapacitated to live beyond certain geographical limits. The range of an insect is governed by various influences which I have not time to enumerate at present; but the principal influence is undoubtedly climate—temperature—heat. The "isothermal" lines, or the lines of equal heat, as all physical geographers are well aware, do not run parallel with the lines of latitude, as one might at first thought suppose; but if our isothermal maps are to be relied on, vary most astonishingly to points north and south of a given line. The same variation from a given line of latitude is noticeable in the distribution of insects, or—to coin a word—we have "isentomic," or iso-insect lines, which are as variable as the lines of equal heat, by which they are doubtless to a great extent governed. In Central Missouri we live on nearly the same latitude as that of Southern Pennsylvania, and in North Missouri, as that of Southern New York; yet we do not live on the same insect line, but nearly on that of Virginia and North Carolina, and even in the extreme northern part of the State, a number of insects are found, which on the Atlantic seaboard are never known to occur north of Virginia, and the same rule holds good with the birds and fishes of the United States. The same thing is true of our Central and Southern counties. In other words many of our insects are *southern*, not *northern* species, and as familiar examples, I might mention the Tarantula of Texas (*Mygale Hentzii*, Girard), and its large Digger-wasp enemy (*Pepsis formosa*, Say), which have been frequently found in St. Louis county during the past two years, though they were for a long time supposed to be confined to Texas.

Now, since the indigenous Potherb Butterfly has never, in the course of past ages, extended to any point South of Pennsylvania, although its cruciferous food-plants have always flourished South of that line, we are justified in concluding that it never will do so, and that though a brood of the worms were introduced directly on to some cabbage patch in the extreme Northern part of this State, they would soon die out there.

Consequently we have nothing to fear from this butterfly which has always troubled our northeastern friends. But the case is very different with another white cabbage butterfly which is now committing sad havoc to the cabbages in some parts of Canada, and some of the Eastern States. The species I refer to is the Rape Butterfly (*Pieris rapæ*, Schrank), a recent importation from Europe, and while I have no fear of any evil results arising from the introduction of the Potherb Butterfly, I should hate to try the experiment of introducing a brood of worms of the Rape Butterfly into any portion of the State; because, for the reasons detailed in the paper read before the State Horticultural Society, and which is published at the beginning of this Report, I have not a doubt but they would flourish exceedingly, and become far more injurious than either of the indigenous species. Indeed, the history of this insect, since its introduction into this country, affords sufficient proof that such would be the result, for M. Provancher in a recent number of his journal, *Le Naturalista Canadien*, says that it alone, has caused more damage around Quebec, since its arrival there, than all other noxious butterflies put together, in the same space of time; and he estimates that it annually destroys $240,-000 worth of cabbages around that town. In short, as this insect is rapidly spreading westward, there is every reason to fear that it may some day get a foothold in our midst, unless the proper measures are taken to prevent such an undesirable occurrence. It will be well therefore to familiarize the reader with its appearance, for "to be fore-warned is to be forearmed!"

Little did I dream, when, many years ago, I watched this butterfly fluttering slowly along some green lane or over some cabbage patch in England, where it is THE butterfly; or when I found its chrysalis so abundantly in the winter time on old palings or even on the kitchen wall indoors—that I should some day be fearing its presence here. But just as little did our forefathers dream of the immense though gradual changes which have come over this broad land during the last two or three centuries! Coming events are said to cast their shadows before them, but verily we know not what the morrow will bring forth.

This Rape Butterfly is the bane of every cabbage grower, and its larva is the dread of every cook in many parts of Europe. Unlike the two indigenous N. A. species already alluded to, this worm is not content with riddling the outside leaves, but prefers to secrete itself in the heart, so that every cabbage has to be torn apart and examined before being cooked, and it is also necessary to keep a continual look-out, even after it is dished up, lest one gets such an admixture of animal and vegetable food as is not deemed palatable by the most of men. It is on account of this habit of boring into the heart of cabbages, that the French call it the "Ver du Cœur" or Heart-worm.

It was introduced about 1856 or 1857, having been first taken in Quebec in 1859. In 1864 Mr. G. J. Bowles, who published an account of it in the *Canadian Naturalist and Geologist*, for August, 1864, p. 258, estimated that it had not then extended more than forty miles from Quebec as a centre. In 1866 it was taken in the northern parts of New Hampshire and Vermont; in 1868 it had advanced as far

South as Lake Winnepesaugee. It having since been taken at Bangor, and at other points in Maine; in certain parts of New Jersey, and the past year around Boston and New York.

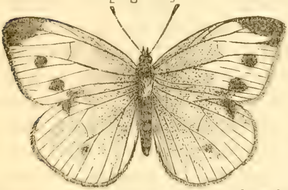
It was in all probability introduced into this country in the egg state, for the eggs are deposited on the underside of the leaves, and there is nothing more likely than that a batch may have been thrown with refuse leaves from some vessel, and that after hatching the young larvæ managed to find suitable food close by.

[Fig. 77.]

The larva (Fig. 77, *a*), is pale green, finely dotted with black, with a yellowish stripe down the back, and a row of yellow spots along each side in a line with the breathing holes. When about to transform, it leaves the plant upon which it fed, and shelters under the coping of some wall or fence, or on anything that may be conveniently at hand, and changes to a chrysalis (Fig. 76, *b*) which though variable in color, is usually pale green, speckled with minute black dots. The insect passes the winter in this state and as with the two indigenous species, there are two broods each year.

The butterflies have the bodies black above, with the wings white, and marked as in the accompanying cuts; the female (Fig. 78) being distinguished from the male (Fig. 79) by having two round spots (sometimes three) instead of only one on the front wings. Underneath, both sexes are alike, there being two spots on the front wings and none on the hind ones, which are yellowish, sometimes passing into green. The species varies very much, and there is a specimen in my collection in which all the spots are so nearly obsolete above, that if it were not for the characteristic under-surfaces, it could scarcely be distinguished from the Potherb Butterfly. There is also in England a variety of the male sex which has the ground-color canary yellow instead of white, and curiously enough, this same variety has been taken in this country.

[Fig. 78]

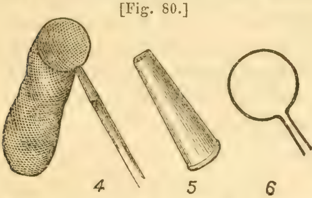


[Fig. 79.]

Although some caterpillars are polyphagous, feeding indiscriminately on a great variety of plants, yet most of them are confined to plants of the same botanical family, or at all events of the same natural order. Such is the case with the two indigenous cabbage butterflies above mentioned, for they are not known to go beyond cruciferous plants for food. The Rape Butterfly has a less epicurean palate however, and departs from this rule, inasmuch as it has been known to feed upon the weeping willow in England.

REMEDIES.—One way of counterworking the evil effects of these cabbage butterflies, is to search for the eggs at the proper season, and destroy them. These eggs are pear-shaped, yellowish and longitudinally ribbed, but as they are deposited singly or in clusters of not more than two or three, the operation becomes tedious and somewhat impracticable on a large scale. Still, children should be taught how to find them, and incited to search for them by the hope of a reward for a certain number. The butterflies are slow lumbering flyers and may easily be caught in a net and killed. A short handle, perhaps four feet long, with a wire hoop and bag-net of muslin or musquito netting, are the only things needed to make such a net, the total cost of which need not be more than fifty or seventy-five cents. Or a more durable one may be made, in the following manner: Get a tinsmith

[Fig. 80.]



4 5 6

to make a hollow handle of brass or tin from six to seven inches in length and tapering at one end, as seen in Figure 80, 5; then procure a piece of stout wire, rather more than a yard long, and bend it in the manner shown in Figure 80, 6. Place the ends of the wire in the small end of the handle, solder it on, and then fill in one-third of the handle with molten lead, so as to make the wire doubly fast and solid. Now make a bag of some strong but light fabric, and fasten it well to the wire. The depth of the bag should be more than twice the diameter of the wire hoop. If a handle is required, a wooden one is easily made to fit into the hollow brass or tin, as at Figure 80, 4. Poultry, if allowed free range in the cabbage field, will soon clear off the worms of our indigenous species.

By laying pieces of board between the cabbage rows, and supporting them about two inches above the surface of the ground, the worms will resort to them to undergo their transformations, and may then be easily destroyed.

Either Paris green or white hellebore will kill the worms, if sprinkled on to them, but cannot be used on cabbages, as it is difficult to free the plants of these substances which are poisonous. The saponaceous compounds of cresylic acid are effectual, and without these objections.

In Europe there are many parasites which serve to check the increase of the Rape Butterfly, and Curtis enumerates at least four. But on this continent, but one such parasite has so far been found to attack it, and that was a two-winged fly—probably a *Tachina* fly—which M. Provancher bred from the chrysalis, in Quebec, Can.* M. Provancher, after remarking that he found a chrysalis which, from its blacken-

*(*Naturaliste Canadien* Vol. II, p. 18.)

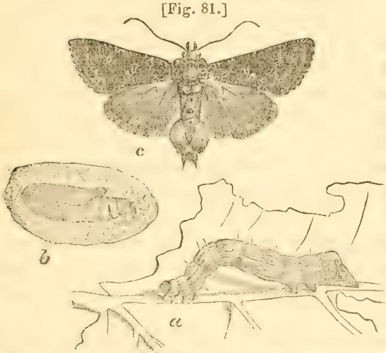
ing in the middle, he suspected would not develop into a butterfly, says of this parasite that he afterwards found a cocoon [pupa?] by its side which was smooth blackish and oblong, and so large that he could scarcely believe it had escaped from the chrysalis, which was, however, now pierced in the middle and empty. M. Provancher goes on to say: "Ten days afterwards, we perceived one morning that the cocoon was open at one end, and there was buzzing about in the vial a fly, which we recognized as belonging to the genus *Sarcophaga* [flesh-flies], the larvæ of which are known to develop in meat. Here then, we exclaimed, when we saw this fly, is an enemy of the Rape Butterfly. But unfortunately the flesh-flies feed indiscriminately on almost any kind of flesh, and never being very numerous, cannot become very redoubtable enemies of this butterfly."

With all due respect to my friend Provancher, I incline to believe that he has mistaken a *Tachina* fly which is a true parasite, for a flesh-fly (*Sarcophaga*) which is only a scavenger. And if this be so, his reasoning falls to the ground, for, as we may see in the Army-worm article in this Report, there are no more efficient checks to the increase of injurious insects than these same *Tachina* flies.

THE CABBAGE PLUSIA—*Plusia brassicæ*, N. Sp.

(Lepidoptera, Plusidæ.)

[Fig. 81.]



This is the next most common insect which attacks the Cabbage with us, and curiously enough it has never yet been described. It is a moth, and not a butterfly, and flies by night instead of by day. In the months of August and September the larva (Fig. 81, *a*) may be found quite abundant on this plant, gnawing large, irregular holes in the leaves. It is a pale green translucent worm, marked longitudinally with still paler more opaque lines, and like all the known larvæ of the family to which it belongs, it has but two pair of abdominal prolegs, the two anterior segments which are usually furnished with such legs in ordinary caterpillars, not having the slightest trace of any. Consequently they have to loop the body in marching, as represented in the figure, and are true "Span-worms." Their bodies are very soft and tender, and as they live exposed on the outside of the plants, and often rest motionless, with the body arched, for hours at a time, they are espied and devoured by many of their enemies, such as birds, toads, etc. They are also subject to the attacks of at least two parasites and die very often from disease, especially in wet weather:

so that they are never likely to increase quite as badly as the butterflies just now described.

When full grown this worm weaves a very thin loose white cocoon, sometimes between the leaves of the plant on which it fed, but more often in some more sheltered situation; and changes to a chrysalis (Fig. 81, *b*) which varies from pale yellowish-green to brown, and has a considerable protruberance at the end of the wing and leg cases, caused by the long proboscis of the enclosed moth being bent back at that point. This chrysalis is soft, the skin being very thin, and it is furnished at the extremity with an obtuse roughened projection which emits two converging points, and several short curled bristles, by the aid of which it is enabled to cling to its cocoon.

The moth is of a dark smoky-gray inclining to brown, variegated with light grayish-brown, and marked in the middle of each front wing with a small oval spot and a somewhat U-shaped silvery white mark, as in the figure. The male (Fig. 81, *c*) is easily distinguished from the female by a large tuft of golden hairs covering a few black ones, which springs from each side of his abdomen towards the tip.

The suggestions given for destroying the larvæ of the Cabbage Butterflies, apply equally well to those of this Cabbage Plusia, and drenchings with a cresylic wash will be found even more effectual, as the worms drop to the ground with the slightest jar.

PLUSIA BRASSICÆ, N. Sp.—*Larva*—Pale yellowish translucent green, the dorsum made lighter and less translucent by longitudinal opaque lines of a whitish-green ; these consist each side, of a rather dark vesicular dorsal line, and of two very fine light lines, with an intermediate broad one. Tapers gradually from segments 1–10, descending abruptly from 11 to extremity. Piliferous spots white, giving rise to hairs, sometimes black, sometimes light colored ; and laterally a few scattering white specks in addition to these spots. A rather indistinct narrow, pale stigmatal line, with a darker shade above it. Head and legs translucent yellowish-green, the head having five minute black eyelets each side, which are not readily noticed with the naked eye. Some specimens are of a beautiful emerald-green, and lack entirely the pale longitudinal lines. Described from numerous specimens.

Crysalis—Of the normal *Plusia*-form, and varying from yellowish-green to brown.

Moth—*Front wings* dark gray inclining to brown, the basal half line, transverse anterior, transverse posterior, and subterminal lines pale yellow inclining to fulvous, irregularly undulate, and relieved more or less by deep brown margins ; the undulations of the subterminal line more acuminate than in the others, and forming some dark sagittate points ; the basal half-line, the transverse anterior near costa, and the transverse posterior its whole length, being sometimes obscurely double : four distinct equidistant costal spots on the terminal half of wing, the third from apex formed by the termination of the transverse posterior; posterior border undulate with a dark brown line which is sometimes marked with pale crescents ; a series of similar crescents (often mere dots) just inside the terminal space ; the small sub-cellulary silver spot oval, sometimes uniformly silvery-white but more often with a fulvous centre, sometimes free from, but more often attached to the larger one which has the shape of a constricted U, very generally with a fulvous mark inside, which extends basally to the transverse anterior at costa. Fringes dentate, of the color of the wing, and with a single undulating line parallel to that on the terminal border. *Hind wings* fuliginous, inclining to yellowish towards base, and with but a slight pearly lustre ; fringes very pale with a darker inner line. Under surfaces pale fuliginous with a pearly lustre, the front wings with a distinct fulvous mark under the sub-cellulary spots, speckled more or less with the same color around the borders of the wing, the fringes being dentate with light and dark ; the hind wings speckled with fulvous on their basal half, and with the fringes as above. *Thorax* variegated with the same color as front wings, the tufts being fulvous inclining to pink. *Abdomen* ♀ gray, with a few pale hairs near the base, and scarcely extending beyond the margin of the hind wings; ♂ longer, covered with pale silky hairs, a distinct dorsal brown tuft on each of the three basal segments, and two large lateral either fawn-colored or golden-yellow brushes on the fifth segment, meeting on the back and partly covering two smaller brushes on the sixth, which are tipped with black; terminal segment flattened and with two lateral more dusky and smaller tufts: underside of thorax and abdomen gray, mixed with flesh-color. Alar expanse 1.55 inches. Described from numerous bred specimens. In a suite of specimens bred from the same brood of larvæ a considerable difference in the general depth of color is found, some being fully as dark again as others.

Closely resembles *Plusia ni*, Engr., which occurs in Italy, Sicily, France, and the northern parts of America. Mr. P. Zeller of Stettin, Prussia, to whom I sent specimens, considers it distinct however from the European *ni*, and I have consequently given it a name in accordance with its habits.

There is another worm which may be known as the Thistle Plusia, and which occurs on our common thistles, and cannot therefore be considered very injurious. It differs only from that of the Cabbage Plusia in having the sides of the head, the thoracic legs, a row of spots above the lateral light line, and a ring around the breathing pores, black. I have bred from it the *Plusia precationis** of Guenée—an insect whose larval history has not hitherto been known.

THE ZEBRA CATERPILLAR—*Mamestra picta*, Harr.

(Lepidoptera, Apamidæ.)

This is another insect which often proves injurious to our cauliflowers and cabbages, though it by no means confines itself to these two vegetables. Early in June the young worms which are first almost black, though they soon become pale and green, may be found in dense clusters on these plants, for they are at that time gregarious. As they grow older they disperse and are not so easily found, and in about four weeks from the time of hatching they come to their full growth. Each worm (Fig. 82. *a*,) then measures about two inches in length, and is velvety-black with a red head, red legs, and with two lateral yellow lines, between which are numerous transverse white, irregular, zebra-like finer lines, which induced Dr. Melsheimer to call this worm the "Zebra." Though it does not conceal itself, it invariably curls up cut-worm fashion, and rolls to the ground when disturbed.

[Fig. 82.]

It changes to chrysalis within a rude cocoon formed just under the surface of the ground, by interweaving a few grains of sand or a

* Some of these bred specimens approach very near to *Pl. iota*, Gn. and even to *Pl. u-brevis*, Gn.

few particles of whatever soil it happens on, with silken threads. The chrysalis is ¾ of an inch in length, deep shiny brown and thickly punctured except on the posterior border of the segments and especially of those three immediately below the wing-sheaths, where it is reddish and not polished; it terminates in a blunt point ornamented with two thorns. The moth (Fig. 82, *b*,) which is called the Painted Mamestra, appears during the latter part of July, and it is a prettily marked species, the front wings being of a beautiful and rich purple-brown, blending with a delicate lighter shade of brown in the middle; the ordinary spots in the middle of the wing, with a third oval spot more or less distinctly marked behind the round one, are edged and traversed by white lines so as to appear like delicate net-work; a transverse zigzag white line, like a sprawling W is also more or less visible near the terminal border, on which border there is a series of white specks; a few white atoms are also sprinkled in other places on the wing. The hind wings are white, faintly edged with brown on the upper and outer borders. The head and thorax are of the same color as the front wings, and the body has a more grayish cast. There are two broods of this insect each year, the second brood of worms appearing in the latitude of St. Louis from the middle of August along into October, and in all probability passing the winter in the chrysalis state, though a few may issue in the fall and hybernate as moths, or may even hybernate as worms; for Mr. J. H. Parsons, of N. Y., found that some of the worms which were on his Ruta Baga leaves, stood a frost hard enough to freeze potatoes in the hill, without being killed.* I have noticed that the spring brood confines itself more especially to young cruciferous plants, such as cabbages, beets, spinach, etc., but have found the fall brood collecting in hundreds on the heads and flower-buds of asters, on the White-berry or Snow-berry (*Symphoricarpus racemosus*); on different kinds of honey-suckle, on mignonette, and on asparagus: they are also said to occur on the flowers of clover, and are quite partial to the common Lamb's-quarter or Goosefoot (*Chenopodium album*).

On account of their gregarious habit when young, they are very easily destroyed at this stage of their growth.

THE TARNISHED PLANT-BUG—*Capsus oblineatus*, Say.†

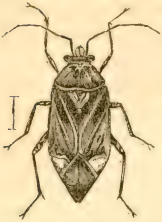
[Heteroptera Capsidæ.]

Quite early last spring while entomologizing in Southern Illinois,

* *Practical Entomologist*, II, p. 21.

† This bug was originally described by Beauvois as *Coreus linearis*, and subsequently as *Capsus oblineatus* by Say. Harris in speaking of it refers it to the sub-genus *Phytocoris* Fallen, and by mistake, changes Beauvois' specific name *linearis*, to *lineolaris*, which he translates into popular language as the "Little-lined Plant-bug." As Say's description is the only one I have access to, I have retained the name he gave it, as being eminently appropriate.

[Fig. 83.]



I spent a day with Mr. E. J. Ayres of Villa Ridge, and was surprised to learn that he had become quite discouraged in his efforts to grow young pear trees, on account of the injuries of a certain bug, which upon examination I found to be the Tarnished Plant-bug, represented enlarged at Figure 83, the hair line at its side showing the natural size. The family to which this bug belongs is the next in a natural arrangement to that which includes the notorious Chinch-bug, and the insect is, like that species, a veritable bug, and obtains its food by *sucking* and not *biting*. The *Capsus* family is a very large one, containing numerous species in this country, but among them, none but the species under consideration have thrust themselves upon public notice by their evil doings.

The Tarnished Plant-bug is a very general feeder, attacking very many kinds of herbaceous plants, such as dahlias, asters, marigolds, balsams, cabbages, potatoes, turnips, etc.; and several trees, such as apple, pear, plum, quince, cherry, etc. Its puncture seems to have a peculiarly poisonous effect, on which account, and from its great numbers, it often proves a really formidable foe. It is especially hard on young pear and quince trees, causing the tender leaves and the young shoots and twigs to turn black, as though they had been burned by fire. On old trees it is not so common, though it frequently congregates on such as are in bearing, and causes the young fruit to wither and drop. I have passed through potato fields along the Iron Mountain Railroad in May, and found almost every stalk blighted and black from the thrusts of its poisonous beak, and it is not at all surprising that this bug was some years ago actually accused of being the cause of the dreaded potato-rot.

This bug is a very variable species, the males being generally much darker than the females. The more common color of the dried cabinet specimens is a dirty yellow, variegated as in the figure with black and dark brown, and one of the most characteristic marks, is a yellow V, sometimes looking more like a Y, or indicated by three simple dots, on the scutel, (the little triangular piece on the middle of the back, behind the thorax). The color of the living specimens is much fresher, and frequently inclines to olive-green. The thorax, which is finely punctured, is always finely bordered and divided down the middle with yellow, and each of the divisions contains two broader logitudinal yellow lines, very frequently obsolete behind. The thighs always have two dark bands or rings near their tips.

As soon as vegetation starts in the spring, the mature bugs which winter over in all manner of sheltered places may be seen collecting on the various plants which have been mentioned. Early in the morning they may be found buried between the expanding leaves, and at this time they are sluggish and may be shaken down and destroyed; but as the sun gets warmer, they become more active, and when approached, dodge from one side of the plant to the other, or else take wing and fly away. They deposit their eggs and breed on the plants, and the young and old bugs together may be noticed through most of the summer months. The young bugs are perfectly green, but in other respects do not differ from their parents except in lacking wings. They hide between the flower-petals, stems and leaves of different plants, and are not easily detected. Late in the fall, none but full grown and winged bugs are to be met with, but whether one or two generations are produced during the season I have not fully ascertained, though in all probability there are two.

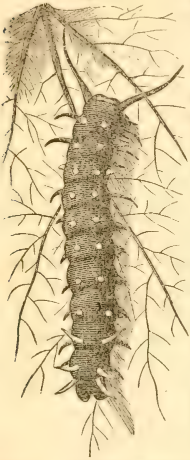
REMEDIES.—In the great majority of cases, we are enabled to counteract the injurious work of noxious insects, the moment we thoroughly comprehend their habits and peculiarities. But there are a few which almost defy our efforts. The Tarnished Plant-bug belongs to this last class, for we are almost powerless before it, from the fact that it breeds and abounds on such a great variety of plants and weeds, and that it flies so readily from one to the other. Its flight is however limited, and there can be no better prophylactic treatment than clean culture; for the principal damage is occasioned by the old bugs when they leave their winter quarters and congregate on the tender buds and leaves of young fruit stock; and the fewer weeds there are to nourish them during the summer and protect them during the winter, the fewer bugs there will be. The small birds must also be encouraged. Applications of air-slacked lime and sulphur, have been recommended to keep them off, but if any application of this kind is used, I incline to think that to be effectual, it must be of a fluid nature; and should recommend strong tobacco-water, quassia-water, vinegar, and cresylic soap. Some persons who have used the last compound have complained that it injures the plants, and every one using it should bear in mind, what was stated in the preface to my First Report, namely, that the pure acid, no matter how much diluted with water, will separate when sprinkled, and burn holes in, and discolor plant texture; while if properly used as a saponaceous wash it will have no such injurious effect. It must likewise be borne in mind, that the so-called "plant-protector" which is a soap made of this same acid, will bear very much diluting, (say one part of the soap to fifty or even one hundred parts of water) and that it will injure tender leaved plants if used too strong. I have noticed that the bugs are extremely fond of congregating upon the bright yellow flowers of the Cabbage, which, as every one knows, blooms very early in the season; and it would be advisable for persons who have been seriously troubled with this bug, and who live in a sufficiently southern latitude where the plant will not winter-kill, to let a patch of cabbages run wild and go to seed in some remote corner of the farm, in order that the bugs may be attracted thither and more readily destroyed, than when scattered over a larger area.

THE PHILENOR SWALLOW-TAIL—*Papilio philenor*, Drury.

(Lepidoptera Papilionidæ.)

There is a genus of climbing plants (the Aristolochias), which is peculiarly attractive on account of its large, rich tropical-looking foliage. The Aristolochias are represented in almost all parts of the world, and some of the tropical species bear beautiful and immense flowers. In this country we have three native species which produce but small, pipe-like flowers, but which make very pretty ornaments for covering walls and arbors or for ornamenting trellises and screens. The most common and best known species in this State is the so called Dutchman's Pipe (*Aristolochia sipho*), but the two other species (*A. serpentaria* and *A. tomentosa*) are also cultivated.

[Fig. 84.]



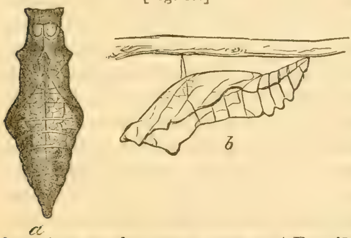
In the beautiful botanical grounds of Mr. Shaw, at St. Louis, there are some magnificent specimens of the Dutchman's Pipe, and about the end of last July, these had all been suddenly defoliated. I was invited to go and examine the cause and propose some remedy. I found the vines literally denuded, for there was not a whole leaf upon them, those that were not entirely eaten off down to the stem, being riddled with different sized holes. Upon a close examination, the authors of the mischief were soon found, in the shape of the peculiarly horned caterpillar, represented at Figure 84; but as there were few large specimens to be found, it was quite evident that the great bulk of them had acquired their growth, and had already left the vines for some more sheltered situation, in which to transform to the chrysalis state. There were, however, a sufficient number of smaller or more recently hatched individuals, had they remained undiscovered, to have soon taken every vestige of the few imperfect leaves remaining; while the beautiful butterflies which produced these worms were noticed flitting around the vines.

This insect is found on no other plants but the Aristolochias. The worms commence to hatch in this latitude by the beginning of July, from eggs deposited on the leaf; and individuals may be found as late as the last of August. They live in company, especially while young, and cover the leaves with zigzag lines of silk, which enable them the better to crawl about and hold on to the vines. The newly hatched worm is dark brown, with no spots, and with quite short tubercles. After the first month they become lighter colored, with the tubercles on the back of segments 6, 7, 8 and 9, of an orange color, and some of the other tubercles, especially the two on the first segment, proportionally longer than the rest. After the second moult the color of the body becomes still lighter, some of the tubercles still proportionally longer and longer, and those on the back all begin to appear orange; while a distinct orange spot becomes visible between the long horns on the first segment, from which spot the soft, forked orange scent-organs are thrust. After the third moult but very little change takes place, and after the fourth moult, the worm loses in a great measure its shiny appearance, becomes more velvety and darker, and when full grown presents the appearance of Figure 84, and may be described as follows:

Length, two inches. Color velvety black, with a slight purplish or chesnut-brown hue. Covered with long fleshy tubercles of the same color as body, and shorter orange colored tubercles, as follows: Two, which are brown, long, tapering and feeler-like, springing anteriorly one from each side of joint 1, the two being movable, and alternately applied to the surface upon which the worm moves. Joint 2, with two brown tubercles, one springing from each side with a downward curve, and each about one-third as long as those on joint 1; also with two small dorsal, wart-like orange tubercles. Joints 3 and 5 exactly like joint 2, but on joint 4 the lateral brown tubercle is replaced by a wart-like orange one. Joints 6, 7, 8 and 9, each with two small dorsal orange tubercles, and each with a lateral, elongated, pointed, brown, downwardly curved one, arising from the base of prolegs. Joints 10 and 11 also with these lateral tubercles, but the orange dorsal ones replaced by longer pointed curved brown ones, which however often have an orange base. Joint 12 with two somewhat stouter dorsal brown tubercles, but none at sides. Joints 7, 8, 9 and 10, each with a lateral orange spot just before and above the spiracles, which are sunk into the flesh and scarcely perceptible. Head, legs, venter and cervical shield the same color as body, the venter with two tubercles on joint 5, which much resemble prolegs, the cervical shield, with an orange transverse spot on anterior edge, from which is thrust the osmaterium.

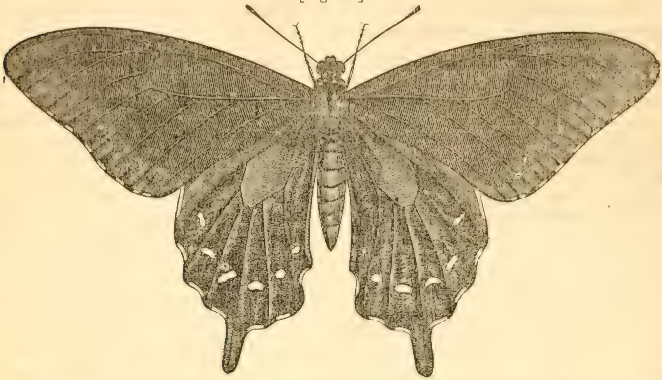
When full grown this tubercled worm fastens itself by its hind legs and by a silken loop drawn between joints 5 and 6, and in about two days changes to a chrysalis, of which Figure 85, *a*, gives a shaded back-view, and *b* a lateral outline. This chrysalis is at first yellowish-green, but soon becomes beautifully marked with gray and violet, and more or less with yellow on the back: and it is readily distinguished from all other chrysalides of North American butterflies belonging to the same genus (*Papilio*) by two trigonate prominences on the head which give it a square appearance; by a very prominent trigonate projection on the top, and a lesser one each side of thorax; by the wing-sheaths being much dilated and sharply edged above, and by six prominent, rounded, narrow edged, longitudinal projections on the top of the three principal abdominal joints.

[Fig. 85.]



The butterfly which issues from this chrysalis in about three weeks, is such a delicate and elegant object, that it is next to impossible to give a just illustration of it. The front wings are black with a greenish metallic reflection on the nerves and along the front and hinder borders, and a row of white spots near the hinder border, which is very slightly undulate, with a narrow cream-colored mark on the inner sinuses. The hind wings are of a brilliant steel-blue, with a greenish cast, with a carved row of white lunules and with the hinder border quite undulate and the inner sinuses cream-colored. The under surface of the front wings is more sombre than the upper surface, with the spots near the borders and tne marginal lunules more distinct. The under surface of the hind wings, is on the con-

[Fig. 86.]



trary, with the exception of a large almost oval patch at base, of a very brilliant steel blue, with a curved row of seven rounded spots of a deep orange, bordered with black, and the four or five upper ones edged above with white ; there is a small yellow basal spot, about five small whitish spots around the lower borders of the large sombre oval patch, and the marginal lunules are much more distinct than on the upper surface. The male which I illustrate (Fig. 86) differs from the female in the more brilliant hue of the upper surface, and in either entirely lacking the row of white spots near the hinder border of the front wings, or in having but the faintest trace of them.

As these Aristolochia worms are semi-gregarious, and as when young, all the individuals of a batch may be found close together, they are easily destroyed, and those persons who cultivate the Aristolochias, need never be troubled with this insect, if they will examine the vines carefully during the first half of July. The worms invariably produce butterflies during the fall months, and the insect consequently hybernates in the perfect or butterfly state. As the worms feed only on the Aristolochias, scarcely a plant of the kind can be grown without sooner or later being attacked, and the gardener should always keep a watchful eye for the worms, about the time indicated.

THE COTTONWOOD DAGGER—*Acronycta populi*, N. Sp.

(Lepidoptera Acronyctadæ.)

[Fig. 87.]

The Cottonwood tree (*Populus monilifera*), though not very generally cultivated in the more thickly settled parts of the country, is yet a valuable tree, especially in the newly settled parts of the West, where by its rapid growth and large foliage, it soon furnishes both wood and shade on the bleak treeless prairies. Besides several borers which eat into the trunk and root, it is attacked in this State by a very curious lazy caterpillar, which devours the foliage, and not unfrequently strips the tree.

This caterpillar (Fig. 87) when full grown, rests curled round upon the leaf, and is easily recognized by its body being covered with long soft bright yellow hairs which grow immediately from the body, part on the back, and curl round on each side. It has a shiny black head, black spots on the top of joints 1 and 2, and a straight black brush on top of joints 4, 6, 7, 8 and 11. There are two broods of these worms each year, the first brood appearing during the month of June and producing moths by the last of July, the second brood appearing the last of August and throughout September, and passing the winter in the chrysalis state. The chrysalis is dark shiny brown, and ends in an obtuse point which is furnished with several hooked bristles. It is formed within a pale yellow cocoon of silk intermingled with the hairs of the caterpillar, and is generally built in some sheltered place, such as a chink in the bark of a tree, or under the cap of some fence.

[Fig. 88.]

The moth (Fig. 88, ♀) is of a pale gray, marked with black as in the figure. It belongs to a night-flying genus (*Acronycta*) of true Owlet-moths, very closely allied to our common cut-worm moths; and yet the larvæ belonging to this genus have none of them the cut-worm habit of concealing themselves under ground, and are exceedingly heterogeneous among themselves. Some are furnished with long soft hairs like the species under consideration; some with prominent hairy warts; some have protuberances on certain segments; some are furnished with brushes; others not, etc., etc. But notwithstanding this dissimilarity among the larvæ of the genus, the moths bear very close resemblances to one another, and in some cases it is not easy to separate them without knowing the larvæ. Our Cottonwood species has never been described. It bears a strong resemblance to several European species, but as it would only weary the general reader to give the details wherein it differs from those already described, which closely resemble it, these details will be found to accompany the scientific description below.

This insect would undoubtedly become much more numerous and troublesome, were it not for the fact that it is pursued by three distinct parasites. Many of the worms when full grown will fasten themselves firmly to a leaf in the curled position, and from the body will issue from thirty to forty little maggots. These maggots are each of them 0.17 inch long, of a dull green color, tapering each way, with a dark dorsal mark, a lateral elevated ridge, and a row of shiny elevated spots of the same color as the body between this ridge and the back. Each one spins a mass of white silk around its body, and creeps out of it and commences spinning afresh, until at last a large aggregate amount of flossy silk is spun, into which the maggots work back to transform, though some transform while lying on the surface. These maggots eventually produce a little black Ichneumon-fly belonging to the genus *Microgaster*.* Another and larger undetermed Ichneumon-fly belonging to the genus *Ophion*, also attacks this Cottonwood worm, and it is also occasionally infested with a *Tachina*-fly larva.

These worms are most easily destroyed when young, for though not strictly gregarious, they do not then scatter much from the branch upon which they were born.

Acronycta populi, N. Sp.—*Larva*—Length 1.50. Color yellowish-green, covered with long soft bright yellow hairs which spring immediately from the body, part on the back, and curl round on each side. On top of joints 4, 6, 7, 8 and 11, a long straight double tuft of black hairs, those on 7 and 8 the smallest. Head polished black with a few white bristles. Joint 1 with a black spot above, divided longitudinally by a pale yellow line, giving it the appearance of a pair of triangles. Joint 2 with two less distinct black spots. Thoracic legs black; prolegs black with brownish extremities. Venter greenish-brown. Described from many specimens. When young of a much lighter color, or almost white, with the black tufts short but more conspicuous, with a distinct black dorsal line, two lateral purplish-brown bands, and with hairs white, sparse and straight.

Individuals vary much: some have a black dorsal line, some have but three distinct black tufts; some have a 6th tuft of black hairs on joint 9, and others have a few black hairs on all but the thoracic joints. Just before spinning up, many of the hairs are frequently lost, and the body acquires a dull livid hue.

Moth.—♀, Front wings, white, finely powdered with dark atoms which give them a very pale gray appearance; marked with black spots as follows: a complete series of small spots on posterior border extending on the fringes, one between each nerve; near the anal angle between nerves 1 and 2 a large and conspicuous spot bearing a partial resemblance to a Greek *psi*, placed sidewise, and from this spot a somewhat zigzag line running parallel with posterior border, but somewhat more arcuated towards costa, least distinct between nerves 3 and 4, and forming a large distinct dart-like spot between nerves 5 and 6; space between this line and posterior border, slightly darker than the rest of the wing-surface on account of the dark atoms being more thickly sprinkled over it; four costal marks, one subobsolete in a transverse line with the reniform spot, one conspicuous about the middle, and in a line with reniform spot and anal angle, one about the same size as the last and looking like a blurred X about one-third the length of wing from base, and one subob-

*Microgaster acronyctæ of my MS.

solet, near the base; orbicular spot flattened and well defined by a black annulation; reniform spot indicated by a blurred black mark running on the cross-vein and sometimes somewhat crescent-formed; a V-shaped spot pointing towards base half-way between costa and interior margin, in a transverse line with the large costal spot which looks like a blurred X; a blurred mark in middle at base, and lastly a narrow spot on the inferior margin, half-way between base and anal angle. Hind wings same color as front wings; somewhat more glossy, with the lunule, a band on posterior border one-fourth the width of wing, and sometimes a narrow coincident inner line, somewhat darker than the rest; the posterior border also with a series of spots one between each nerve. Under surface of front wings pearly-white with an arcuated brown band, most distinct towards costa, across the posterior one-third, all inside of this band of a faint yellowish-brown; lunule and fringe spots distinct, and with a faint trace of the *psi*-spot; hind wings uniform pearly-white with a distinct and well defined dark wavy line running parallel with posterior margin across the posterior one-third of wing, and with the lunule and fringe spots distinct. Antennæ simple and bristle-formed, gray above, brown beneath. Head thorax and body, both above and below, silvery-gray. Legs with the tarsi alternately dusky and gray. ♂ differs from ♀ by his somewhat stouter antennæ; much narrower body, and narrower wings and fringes, the front wings having the apex more acuminate, and the hind wings scarcely showing the darker hind border.

Described from 2 ♀, 2 ♂ all bred. In the ornamentation of the front wings this species bears some resemblance to the European species *tridens* and *psi*, but otherwise differs remarkably, and especially in its larval characters. It bears a still closer resemblance both in the larva and imago state to the pale variety of a common species known in England as the "Miller" (*A. leporina*), but judging from the figures and description in "Newman's Natural History of British Moths," it may be easily distinguished from *leporina* by the well defined orbicular spot, by the greater proximity of the two large costal spots, by lacking a round spot behind the disk, and by the more prolonged apex. It differs also in the larva state from *leporina* which feeds on the Birch. It likewise closely resembles *interrupta*, though the larvæ are remarkably different; and it also resembles *lepusculina*, the larva of which is unknown; but the specific differences will be readily perceived upon comparing Guenée's descriptions. How near it approaches to *Acronycta occidentalis*, Grote,* it is impossible to tell, as the author's description is exceedingly brief, considering the number of closely allied forms; but as that species has a bright testaceous tinge on the reniform spot, it evidently differs from mine. Harris's *Apatela* [*Acronycta*] *Americana*,† though very different in the imago, yet closely resembles *populi* in the larva state. I have on two occasions found the larva of *Americana* feeding on the Soft Maple, and it may be distinguished from *populi*, by its greater size; by the paler color of the body; by the hairs being paler, more numerous, shorter and pointing in all directions, especially anteriorly and posteriorly of each segment; by having on each of joints 4 and 6 two distinct long black pencils, one originating each side of dorsum, and on joints 11 one thicker one originating from the top of dorsum; by a substigmatal row of small black spots (three to each segment, the middle one lower than the others) and by a trapezoidal velvety black patch starting from anterior portion of joint 11 and widening to anus.

THE MISSOURI BEE-KILLER—*Asilus Missouriensis*, N. Sp.

(Diptera Asilidæ.)

On page 168 of my First Report an account is given, with a very poor figure, of a large two-winged fly which was first received by Dr.

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*Proc. Ent. Soc. Phil., VI, p. 16.

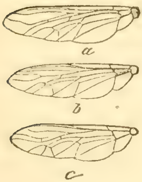
†I am surprised that Dr. Morris (*Harr. Inj. Insects*, p. 436, Note) refers this species to Guenée's *acericola*, when the larva of the latter, as described by Guenée himself, is so different and feeds withal on Birch and Alder, and not on either Maple, Elm, Linden or Chesnut.

[Fig. 89.]

Fitch, of New York, from Mr. R. O. Thompson of this State, who found that it had the pernicious habit of catching and sucking out the juices of the common honey-bee. Dr. Fitch referred this fly to the genus *Trupanea*, and called it the Nebraska bee-killer, from its having first been captured by Mr. Thompson in Nebraska, where he at that time resided. The great German Dipterist, H. Loew, as I am informed by Baron Osten Sacken of New York, ignores and has discontinued the genus *Trupanea*, substituting in its place that of *Promachus*; and Fitch's *Trupanea apivora* is the very same species previously described by Loew as *Promachus Bastardii*, and it is one of the most common species, occurring very generally over the United States.

I find that we have in Missouri a somewhat larger fly (Fig. 89) which has the same pernicious habit of seizing and destroying the honey-bee in preference to all other kinds of prey. It acts in exactly the same manner as the Nebraska Bee-killer, being, if anything, more inhuman and savage. It belongs to the typical genus *Asilus*, and I have called it the Missouri Bee-killer (*Asilus Missouriensis*). Though bearing a casual resemblance to the Nebraska Bee-killer, it may very readily be distinguished from that species, and especially by the different venation of the wings.

[Fig. 90.]



The three more common genera of these voracious *Asilus* flies, may easily be distinguished from each other by the character of these wing-nerves. In the typical genus *Asilus* to which belongs our Missouri Bee-killer, the *third* longitudinal vein is forked near the terminal *third* of the wing, and the vein itself is connected about the middle of the wing, with the fourth longitudinal, as in Figure 90, *b*. In the genus *Promachus*, to which the Nebraska Bee-killer belongs, it is the *second* (not the third) longitudinal vein which is forked near the *middle* of the wing, and the third branch of this fork is connected by a slender cross-vein to the third longitudinal, near the terminal third of the wing, as in Figure 90, *a*. In the genus *Erax*, which generally comprises smaller species, the venation is similar to that of *Asilus*, but the upper branch of the fork, instead of joining the third longitudinal vein, is abruptly broken off and connected only near its termination by a transverse vein, as in Figure 90, *c*.

ASILUS MISSOURIENSIS N. SP.—Alar expanse 1.85; length of body 1.30 inches. *Wings* transparent, with a smoky yellow tinge, more distinct around the veins, which are brown. *Head* pale yellow, sometimes brownish; moustache straw-yellow with a few stiff black hairs below; beard pale straw-yellow; crown very deeply excavated; base of the same pale yellow with short, stiff, yellowish hairs, and a crown of black ones near the border; eyes large, prominent, finely reticulated and almost black; antennæ, first joint black tipped with brown, cylindrical and hairy; second joint black, short, thick and rounded at tip, with a few stiff hairs; third joint as long as first, tapering each way, smooth, black and terminating in a long, brown bristle; proboscis black and nearly as long as face; neck with pale and black hairs. *Thorax* leaden-black, slightly opalescent with reddish brown at sides, more or less pubescent with pale yellow, especially laterally and posteriorly and in three narrow longitudinal dorsal lines which gradually approach towards metathorax; bearded at sides and behind with a few decurved black bristles, those behind interspersed with a few smaller pale hairs; scutel of the same color, with upward-curving, black bristles; halteres brown. *Abdomen*, ♂, general color dull leaden-yellow, with darker transverse bands at insections; the light color produced by a yellowish pubescence and numerous short close-lying yellow hairs, the dark bands produced by the absence of this covering at the borders of each segment; basal segment broad, bilobed, and with lateral black bristles; segments 6, 7, 8 and anal valves with a decided pink tint, especially 7; 8 but one-third as long as 7 above. ♀, broader, flatter, more polished and brassy, with no transverse darker bands, segments 7 and 8 polished black, the latter narrow and longer than any of the others; anus with a few black bristles. *Legs*, dull purple-brown, with black bristles; thighs very stout, the hind pair rather darker than the others, the two front pair of trochanters with long, yellowish hairs; pulvilli, generally fulvous.

Described from two ♂, and two ♀, all captured while sucking honey-bees. I have not access to Loew's descriptions, and cannot therefore compare it with already described species; but specimens have been sent to Dr. Wm. LeBaron, of Geneva, Illinois, and to Baron Osten Sacken, of New York, and both these gentlemen are unacquainted with it, and believe it to be new. In the well marked ♂ specimens, the body bears a general resemblance to that of *Trupanea* [*Promachus*] *vertebrata*, Say.

Of course the apiarian will care very little to know which of these two Bee-killers is weakening his swarms. They should both be unmercifully destroyed, and though very strong and rapid flyers, they may be easily caught when they have settled on any little prominence with a bee in their grasp; for they are so greedy of the bee's juices that they are at this time less wary, and even when disturbed, will fly but a few yards away before settling again. A net such as that described in the article on "Cabbage worms" will be found useful in catching these mischievous flies.

The habits and preparatory stages of our *Asilus* flies are not very well known. They are all cannibals in the fly state, sucking out the juices of their victims with the strong proboscis with which they are furnished, and by which they are capable of inflicting a sharp sting on the human hand. The larvæ are footless, and live in the ground, and such as are known in this state are strangely enough, vegetable-feeders.

[Fig. 91.]

The only N. A. species that has heretofore been bred to the perfect state, is the Silky Asilus (*Asilus sericeus*, Say., Fig. 91) belonging to the typical genus *Asilus*. Its larva feeds upon the roots of the Rhubarb, and was bred to the perfect state by Dr. Harris (*Inj. Insects*, p. 605). I have succeeded in breeding to the fly state another species, belonging however to the genus *Erax*, and subjoin a description of the larva, as it is of considerable scientific interest. The fly is figured below (Fig. 93 *a*).

[Fig. 92.]

ERAX BASTARDI (?)—*Larva*—(See Fig. 92.) Length 1.05 inches. Only twelve joints, the three anterior and the three posterior ones tapering gradually, the rest of equal width; slightly depressed; translucent yellowish-white, the chitinous covering tolerably firm however; a swollen lateral ridge; two rufous dorsal spiracles on joint 1 and two similar ones on joint 11. Head dark brown, very retractile, pointed, divided at tip into two mandibulate points, and having two unguiform appendages; anal segment with two depressed longitudinal lines above, ridged on anterior edge and with a central depressed line below. It makes use of its head in crawling.

Pupa—(Fig. 93 *b*). Stout, honey-yellow; the leg and wing-sheaths soldered together though separated from the abdomen; eyes large and dark; head with two large brown spines in front, and a lateral set of three rather smaller ones; thorax with two small thin rounded dorsal projections and a set of two small lateral spines just behind the head; abdomen, with each segment ridged in the middle and furnished on this ridge with a ring of brown blunt thorns sloping backwards; anal segment with a few rather stouter spines.

[Fig. 93.]

Two specimens, one found by Mr. G. C. Brodhead of Pleasant Hill, Mo., under a peach tree, the other by Mr. G. Pauls of Eureka, Mo., under a "creeping vine" of which he did not know the name. They were found full grown in May, and gave out the flies the fore part of July. Both produced ♀♀, on which account the species cannot be determined with absolute certainty. Osten Sacken informs me that it is allied to *tabescens* Loew, but is different. It is marked *lictor* in my MS., but from Macquart's description of *Bastardi*, and from ♂ and ♀ specimens of that species kindly furnished by Dr. Le Baron, I feel pretty confident that it is ♀ of that species, which is described as follows: *Abdominis segmentis tribus apicalibus niveus* ♂; *omnibus segmentis albido marginatis* ♀. *Pedibus nigris: tibiis rufis: alis flavidis. Long.* 7½ l. He then adds: "Face and front black with gray down; moustache with the upper half black and lower half white; as also the beard. The middle band of thorax divided. The first four segments of the abdomen with the posterior and lateral borders whitish. Extremities of the legs black. From North America. From 3 ♂, I have seen one which had the four terminal segments of the abdomen white." My females accord very well with this description so far as it goes, though I cannot see why Macquart restricts the whitish borders to the first four segments in the French description, when in the Latin it is stated that all the segments are so bordered, which is the case with my specimens.

INNOXIOUS INSECTS.

THE GOAT-WEED BUTTERFLY—*Paphia glycerium*, Doubleday.

[Lepidoptera, Nymphalidæ.)

[Fig. 94.]

There is is an interesting and rare butterfly known to entomologists by the name of *Paphia glycerium*, which occurs in Missouri, Texas and Illinois, and perhaps in other southwestern States. It is an interesting species on account of the dissimilarity of the sexes, and of the position it holds among the butterflies; and as its natural history was unknown till the present year, I will transcribe from the *American Entomologist*, the following account of it, which I was enabled to prepare from specimens kindly sent to me last September by Mr. J. R. Muhleman, of Woodburn, Ills., and from further facts communicated by Mr. L. K. Hayhurst, of Sedalia, Mo.

Dr. Morris, in his "Synopsis of the Lepidoptera of North America," places this butterfly with the *Nymphalis* family, of which the Disippus Butterfly (*Nymphalis disippus*, Godt.), is representative. The larva, however, has more the form and habits of that of the Tityrus Skipper (genus *Goniloba*), while singularly enough, the chrysalis resembles that of the Archippus Butterfly (genus *Danais*).

The larva feeds on an annual (*Croton capitatum*) which is tolerably common in Missouri, Illinois, Kentucky, and westward, where it is known by the name of Goat-weed, and as no value whatever is attached to it, the insect which attacks it cannot be classed among the injurious species. The plant has a peculiar wooly or hairy whitish-green appearance, and in the month of September its leaves may frequently be found rolled up after the fashion shown at the left of Figure 94, with the larva inside. This roll of the leaf is generally quite uniform, and is made in the following manner: Extending itself on the midvein, with its head towards the base of the leaf, the larva attaches a thread to the edge, at about one-fourth the distance from the base to the point. By a tension on this thread, it draws this edge partly toward the opposite one, and fastens it there, being assisted in the operation by the natural tendency of the leaf to curl its edges inwards. Fastening a thread here, it repeats the operation until the edges meet, and then it proceeds to firmly join them nearly to the apex, leaving a small aperture through which to pass the excrement. During hot days the larva remains concealed in the leaf, and towards evening comes out to feed, though sometimes it feeds upon its house, eating the leaf down half way from base to point. It then abandons it and rolls up a new one. In the breeding cage, when placed in a cool shady room, the larva seldom rolls up the leaves, but feeds at random over the plant, and when at rest simply remains extended on a leaf. From this we may infer that its object in rolling the leaves is to shield itself from the rays of the hot August and September sun; for the plant invariably grows on high naked prairies.

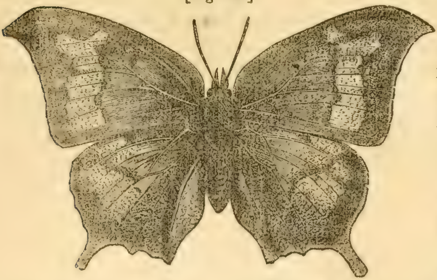
[Fig. 95.]

The young larva has a large head, larger than the third segment, which is the largest in the body. The head preserves its general form through the successive moults; it is light bluish, thickly covered with papillæ of a dirty-white color, and there are also a number of light orange papillæ of a larger size scattered among them. The skin of the caterpillar is *green*, but the general hue is a dirty-white, owing to the entire surface being very closely studded with white or whitish papillæ with dark-brown ones interspersed. These prominences are hemispherical, hard, opaque, shining, and the larva feels rough and harsh to the touch.

At each moult some of these papillæ disappear, especially *all* the brown ones, the body increases in size so that the head is smaller than the third segment, the green color of the skin becomes more apparent, the body is softer to the touch, and the whole larva assumes a neater appearance.

Thus this larva has very much the same peculiar whitish glaucous-green color as the plant on which it feeds; and any one who has seen it upon the plant, cannot help concluding that it furnishes another instance of that mimickry in Nature, where an insect, by wearing the exact colors of the plant upon which it feeds, is enabled the better to escape the sharp eyes af its natural enemies. When full-grown, which is in about three weeks after hatching, this worm (Fig. 94, *a*) measures 1½ inches, and although, as above described, the little elevations frequently disappear so that it looks quite smooth, yet sometimes they remain until the transformation to chrysalis takes place, as was the case with two which I bred.

[Fig. 96.]



PAPHIA GLYCERIUM.—*Full-grown larva*—Length 1.50 inches. Cylindrical. General appearance shagreened, pale glaucous-green, lighter above stigmata than elsewhere. Ground-color, of body clear green. Thickly covered with white papillæ or granulations, which are often interspersed with minute black or dark-brown sunken dots. Head quite large, (rather more than ½ as large as the third segment), nutant, subquadrate, bilobed, granulated like the body, but with the black sunken dots more numerous, and having besides, several larger granulations above, some four of which are generally black and the rest fulvous; a row of three very distinct eye-spots at the base of palpi; the triangular V-shaped piece elongated and well defined by a fine black line, and divided longitudinally by a straight black line; palpi and labrum pale. the latter large and conspicuous; jaws black. Neck narrow, constricted, green, smooth, and retractile within first segment. Segments 1—3 gradually larger and larger; 3 to last gradually smaller. Stigmata fulvous. Venter less thickly granulated than tergum. Described from five full-grown specimens received from Mr. Muhleman.

Preparatory to transforming, it suspends itself by the hind legs to a little tuft of silk which it had previously spun, and after resting for about twenty-four hours with its head curled up to near the tail. it works off the larval skin and becomes a chrysalis, which in from two to three weeks afterwards gives out the butterfly. This chrysalis (Fig. 94, *b*) is short, thick, rounded, and of a light green; sometimes becoming light gray, and being finely speckled and banded with dark gray. The skin is so thin and delicate that the colors of the butterfly may be distinctly seen a few days before it makes its escape.

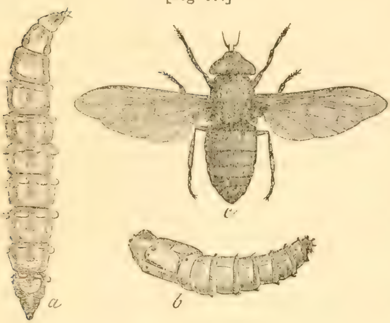
The male butterfly (Fig. 95), is of a deep coppery-red on the upper side, bordered and powdered and marked with dark purplish-brown, as shown in the figure. The under side is of a *feuille morte* brown with a greasy lustre, the scales being beautifully shingled transversely so as to remind one of that article of dry-goods which the ladies call rep; while the bands which commenced on the front wings above, may be traced further across the wing, and there is a transverse band on the hind wings, with an indistinct white spot near the upper edge. The female (Fig. 96), is of a lighter color than the male, marked with purplish-brown as in the figure, the transverse bands being quite distinctly defined with very dark-brown. The under side is very much as in the male.

A few of the butterflies, in all probability, manage to live through the winter, and are thus enabled to perpetuate the race, by depositing their eggs, the following summer, on the leaves and stems of the Goat-weed, which is the only plant upon which the insect is yet known to subsist.

THE BLACK BREEZE-FLY—*Tabanus atratus*, Fabr.

(Diptera, Tabanidæ.)

[Fig. 97.]



There is a family of large Two-winged Flies, commonly called Breeze-flies in England, but more commonly known as Horse-flies in this country, the insects belonging to which are, in the perfect state, great nuisances, though there is every reason to believe that as larvæ they are beneficial to the husbandman, by devouring many noxious underground vegetable-feeding larvæ.

This family comprises some of the very largest flies, and they are all noted for the tormenting powers which the female has of piercing the skin and sucking the blood of different quadrupeds and even of man. They are widely distributed, and species occur in all parts of the world, torturing alike the huge elephant and fierce lion of the tropics, and the peaceful reindeer of the arctic region. It is during the hottest summer months that they "do most abound," and they frequent both our timbered and prairie regions. One of the most common species in the West is the so-called "Green-head Fly" (*Tabanus lineola*, Fabr.) and every farmer who has to work on the prairies, especially during the hay-making season, knows how bloodthirsty it is, and how absolutely necessary it is to cover the horses at this season of the year, in order that they may be able to work at all. Two other species of nearly the same size (*T. costalis*, Wied. and *T. cinctus*, Fabr.) are common with us, and I have found the striped

Chrysops (*Chrysops vittatus*, Wied.)—a smaller yellow species with black stripes, and a broad smoky band across the middle of each wing; to be very troublesome in our wooded regions, confining its attacks more especially to the horses' ears, from which habit it is frequently called the "Ear-fly."

It is only the female flies, as is the case also with our mosquitoes, which thus torment our animals by means of their sharp lances, the males living on the sweets of flowers, and their mouths being destitute of mandibles. The flight of these Breeze-flies is very strong and rapid, and is attended with a buzzing, tormenting noise. The males may often be seen with the wings vibrating so rapidly that they become invisible, resting motionless in one place, and then darting rapidly and resting suddenly again, generally turning the head in some other direction each time they dart; and St. Fargeau has ascertained that this manœuvering is performed in order to intercept and seize the females.

Although these flies swarm so prodigiously on our prairie and especially on our low swampy lands, yet hitherto very little has been known of their larval character and habits. De Geer very many years ago described the larva of the European Cattle Breeze-fly (*Tabanus bovinus*, Linn.), and up to 1864 this was the only larva of the kind known. In February of that year Mr. Walsh published the description of another Tabanide larva, but without being able to refer it to any particular species.* I had the good fortune last summer to breed to the perfect state the very same kind of larva which Mr. Walsh described. It proved to be one of our most common and largest species, namely The Black Breeze-fly (*Tabanus atratus*, Fabr.) This Fly (Fig. 97, *c*) is black, the back of the abdomen being covered with a bluish-white bloom like that on a plum; the eyes are large, and the wings are smoky dark brown or black.

The larva (Fig. 97, *a*) is a large 12-jointed, cylindrical affair, tapering at each end, of a transparent, highly polished, glassy, yellowish or greenish appearance, shaded with bluish-green and furnished above and below, as in the figure, with large roundish sponge-like tubercles which are retracted or exserted at the will of the insect. Though the external integument is so transparent, that the internal structure is readily visible, yet this integument is firm and the larva is most vigorous and active, burrowing with great strength either backwards or forwards in the earth, and between one's fingers while it is being held. Placed in water it will swim vigorously by suddenly curling round and lashing out its tail, but it is apparently not as much at home in this element as in the wet earth, for it is restless and remains near the surface, with the tip of the tail elevated in the air. When the water is foul it moves about actively near the surface, but when it is fresh it remains more

*Proc. Bost. Soc. Nat. Hist., Vol. IX, pp. 302–6.

quiet at the bottom. The specimen which I succeeded in breeding, was sent to me by Mr. Adolph Engelmann of Shiloh, St. Clair Co., Ills. It was found by Mr. Wm. Cooper of the same county, about ten feet from a small but permanent stream of water. Mr. C. at first took it to be a leech, and when he attempted to capture it, it immediately commenced burrowing in the ground.

Mr. Walsh's description of this larva is so full, and agrees so well with mine, that I cannot do better than transcribe it.

TABANUS ATRATUS.—*Larva,*—Length 2.25 inches when extended, 1.75 inches when contracted : diameter .25—.30 inch. Body cylindrical, 12-jointed, the three or four terminal joints much tapered at each end of the body, but more so anteriorly than posteriorly, and joints 1 and 11, each with a retractile membranous prolongation at tip. Joints 1 to 10 are subequal ; 11 is about two-thirds as long as 10 and 12 about one-fourth as long, and .05 inch in diameter. [Joints 1 and 12 pear-shaped when extended]. Color a transparent greenish-white, paler beneath ; an irregular dark-green or greenish-black annulus, paler beneath, on the anterior and posterior margins of joints 2 to 11, the anterior annulus laterally connected with the posterior by two to four dark-green lines. On the dorsum of 4 to 9, and more obscurely on 10, a dark-green basal triangle, extending half-way to the tip ; joint 1 with paler markings, and with no dark annulus behind ; joint 12 entirely fuscous. Head small, apparently fleshy, pale, truncate-conical, .03 inch wide, and about .04 inch long in repose, inserted in joint 1 without any shoulder. The trophi occupy two-thirds of its length, but it has a long cylindrical internal prolongation, extending to the middle of joint 2, which is sometimes partially exserted, so that the head becomes twice as long as before. All the trophi are pale and apparently fleshy, except the mandibles, which are dark-colored and evidently horny, and they have no perceptible motion in the living insect. The lubrum is slender, a little tapered, and three times as long as wide, on each side of and beneath which is a slender, thorn-like, decurved, brown-black mandible. The labium resembles the labrum, but is shorter, and on each side of it is a slender palpiform, but exarticulate maxilla, extending beyond the rest of the mouth in an oblique direction. No palpi. On the vertex are a pair of short, fleshy, exarticulate, filiform antennæ, and there are no distinct eyes or ocelli. In the cast larval integument the entire head, .25 inch long, is exserted, and is dark-colored and evidently horny, all the parts retaining their shape except the antennæ, labrum and labium. The whole head has here the appearance of the basal part of the leaf of a grass-plant, clasping the origin of the maxillæ on its posterior half, and bifurcating into the somewhat tapered cylindrical mandibles on its anterior half. The maxillæ are traceable to two-thirds of the distance from the tip to the base of the head, scarcely tapering, bent obliquely downwards at two-thirds of the way to their tip, and obliquely truncate at tip. On the anterior margin of ventral segments 4—10, in the living insect, is a row of six large, fleshy, roundish, tubercular, retractile pseudopods, the outside ones projecting laterally, and each at tip transversely striate and armed with short, bristly pubescence ; on the anterior half of ventral joint 11 is a very large, transversely-oval, fleshy, whitish, retractile proleg, with a deeply impressed, longitudinal stria. On the anterior margin of dorsal joints 4—10, is a pair of smaller, transversely-elongate, retractile, fleshy tubercles, covering nearly their entire width, armed like the pseudopods, but not so much elevated as they are. No appearance of any spiracles. Anus terminal, vertically slit with a slender, retractile thorn .05 inch long, not visible in one specimen. Head, and first segment or two, retractile.

The larva reared by De Geer was terrestrial. This larva is semi-acquatic, for it is quite at home either in water or moist earth. My specimen was kept for over two weeks in a large earthen jar of moist earth well supplied with earth-worms. It manifested no desire to come to the surface, but burrowed in every direction below. I found several pale dead worms in the jar, though I cannot say positively whether they had been killed and sucked by this larva. Mr. Walsh in speaking of its haunts and of its food, says : "I have, on many different occasions, found this larva amongst floating rejectamenta. On one occasion I found six or seven specimens in the interior of a floating log, so soft and rotten that it could be cut like cheese. Once I discovered a single specimen under a flat, submerged stone, in a little running brook. And finally, I once met with one alive, under a log, on a piece of dry land which had been submerged two or three weeks before, whence it appears that it can exist a long time out of the water. I had, on several previous occasions, failed to breed this larva to maturity, and the only imago I have, was obtained in 1861, from larvæ, which, suspecting them to be carnivorous from the very varied stations in which they had occurred, I had supplied with a number of fresh-water mollusks, but the habits of which, in consequence of having been away from home, I was unable to watch. On September 2d, 1863, I found a nearly full-grown larva amongst floating rejectamenta, and between that date and September 23d, he had devoured the mollusks of eleven univalves (*Gen. Planorbis*) from one-half to three-fourths of an inch in diameter; and on three separate occasions I have seen him work his way into the mouth of the shell. In this operation his pseudopods were energetically employed, and I found, on cracking the shells after he had withdrawn, that a small portion of the tail end of the animal was left untouched—no doubt in consequence of his being unable to penetrate to the small end of the whorl of the shell—and also the skin of the remaining part, and the horny-tongued membrane."

My larva transformed to pupa (Fig. 97, *b*) within the ground, during the fore part of July; it remained in this state but a few days, and the fly issued July 13th, and soon made its presence known by its loud buzzing inside the jar. It was a perfect ♀ specimen, and the pupal integument was sufficiently firm and polished, that by carefully washing off the earth, an excellent cabinet specimen was obtained, which retained almost the exact form and appearance of the living pupa. Before the escape of the fly which was effected through a longitudinal fissure on the back of the head and thorax, reminding one of the mode of escape of our Harvest-flies (*Cicadæ*), this pupa by means of the thorns with which it is furnished, had pushed itself up to the surface of the earth. My specimen being female, may account for the very slight difference between the following description and that of Mr. Walsh's.

Pupa, (described from pupal integument).—Cylindrical, lying curved as in the figure; rounded at the head, and tapering at the last two joints; pale semi-transparent yellowish-brown. *Head* with two transverse, narrow-edged, somewhat crescent-shaped dark-brown projections representing the mouth, two rounded tubercles above, on the front, of the same color, and each giving out a stiff bristle; and midway between these four, two much smaller, lighter, rounded tubercles, set closer together; on each side in a line with the upper tubercles, a wrinkled antenna, trigonate at base, appressed to the surface and pointing outwards; below these antennæ, on the eyes, two small bristled warts. *Thorax*, pronotum commencing behind antennæ, with a pair of small bristled brown tubercles* on its anterior dorsal submargin; mesonotum twice as long as pronotum, with a pair of large obliquely-placed, reniform, purple-brown tubercular spiracles, bordered on the outside above, with a distinct fine white line; between these spiracles are four small brown elevations the two middle ones quite small and close together; a short metanotal piece, about one-seventh as long

*Evidently not spiracles as Mr. Walsh supposed. The mesonotal spiracles are well defined, with the white border above mentioned, and the abdominal spiracles are each marked behind by a distinct white line; but these tubercles have no such annulus and are illy defined.

as pronotum and without spiracles. *Abdomen*, with 8 subequal segments, with two well defined lateral impressed lines, and all but the last bearing between these lines, a rounded brown tubercular spiracle, the posterior upper borders lined with white. The first segment is simple and extends to the tips of the wing-sheaths; the others are all furnished, on the posterior one-third, with an annulus of fine, yellowish bristles, depressed and directed backwards. Anal thorn robust, yellow, truncated, and furnished with six stout brown thorns, hexagonally arranged. Length 1.20 inches; greatest diameter 0.30 inch. One ♀ specimen.

This large Black Breeze-fly does not attack horses to any considerable extent that I am aware of, but is said to bite cattle. The smaller species of real Horse-flies mentioned above, and which occur in prodigious numbers on our Western prairies, away from any large streams of water, must evidently be terrestrial in the larva state, and not aquatic, and must just as surely live on other food than snails, which are quite rare on the prairies. They are certainly carnivorous however, and it is but natural to suppose that they feed on underground vegetable-feeding larvæ, such as the different kinds of white grubs, the larvæ of Crane-flies (*Tipulidæ*), etc. Thus, in all probability, they perform a most important part in the economy of Nature, by checking the increase of those underground larvæ which are the most unmanageable of the farmer's foes. They therefore partly atone for the savage and blood-thirsty character of the perfect females, and I prefer consequently to place them with the other Innoxious Insects.

GALLS MADE BY MOTHS.

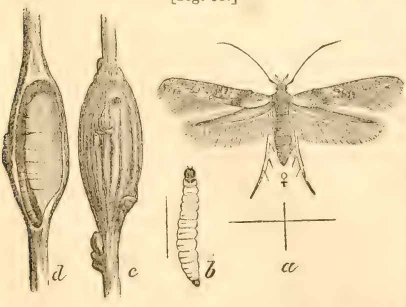
As a sequence to the article on the Solidago Gall Moth (*Gelechia gallæsolidaginis*, Riley) published in my former Report, I will here describe two other gall-making moths, with which I was not then acquainted, the first of which, as I have since ascertained, occurs in this State. The other I have never yet met with.

THE FALSE INDIGO GALL-MOTH—*Walshia amorphella*, Clemens.

(Lepidoptera, Tineidæ.)

On the leafless stems of the False Indigo (*Amorpha fruticosa*) may often be seen, during the fall, winter and spring months, an elongated swelling such as that shown at Figure 98, *c*, two of them often occurring one above the other. This swelling is a simple enlargement of the stem to five or six times its natural diameter, and measures from three-quarters of an inch to an inch in length. If cut open during any of the winter months, the interior will present a tough woody appearance, with an irregular brown channel, almost always

[Fig. 98.]



at one side of the gall, and communicating above with a small closed-up tubercle (See Fig. 98, *d*,). At the bottom of this channel the larva (Fig. 98, *b*, enlarged), which is whitish with a conspicuous black head and black collar, may always be found, and it does not transform to the chrysalis state till a few weeks before appearing as a moth. The tubercle near the top of the gall is evidently caused by the young larva penetrating the stem when it first hatches out; and this larva must, after it has burrowed the proper length down the stem, turn round and widen the burrow right up to the point of entrance; for it is from this point that the moth escapes in the spring. The moth, of which Figure 98, *a*, represents an enlarged female, is easily distinguished from most other small moths belonging to the same family (*Tineidæ*) by its beautifully tufted front wings, which are not easily represented in a wood-cut. It is of a yellowish-brown color, marked with darker brown, and the males are generally a little darker than the females. This little moth was first described by Clemens (Proc. Ent. Soc. Phil., Vol. II, p. 419), who named the genus in honor of Mr. Walsh, its first discoverer, and so far as I am aware it is the only representative of the genus.

The twigs invariably wither and dry up above this gall, but as the shrub has no particular value, the little gall-maker may be placed among the harmless insects.

WALSHIA AMORPHELLA—*Larva*—Length 0.35—0.40 inch. Cylindrical, tapering each way, but more especially towards anus. Yellowish-white, each segment with about two distinct transverse folds. Two dorsal rows of pale but polished piliferous spots, two to each segment; stigmata round, jet black with a white centre, with a pale piliferous spot above, and two contiguous ones on a lateral fold, below each; on joints 1 and 2 the folds are more numerous and the piliferous spots are larger and arranged in a transverse row. Head either black or dark brown, the trophi except the maxillæ white, and the eyelets, arranged in a crescent, also pale. Cervical shield same color as head, divided in the middle by a distinct pale line. Both have a few white hairs, arising from pale points. Anal shield small and brown. Thoracic legs pale but slightly horny, transparent, furnished with hairs, and with two basal semi-circular brown lines behind, the largest terminating on the inside, in a black thorn. Prolegs very small and scarcely distinguishable except by a faint brown circular rim at extremities, and a still fainter one at their base. Described from numerous specimens, all very uniform.

Pupa—Unknown.

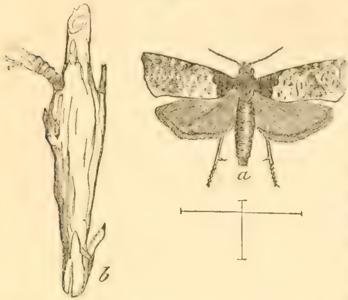
Moth—Front wings yellowish-fuscous, with a rather large blackish brown patch at the base of the wing, somewhat varied with spots of the general hue, and a blackish-brown tuft, having the scales directed toward the tip of the wing, on the basal third of the fold, and a smaller one above it near the costa. Near the end of the fold is another small tuft of the general hue, having the ends of the scales tipped with dark brown, and in the middle of the wing nearly adjoining the latter is a large tuft of the general hue. Above the end of the fold is a small blackish-brown tuft, the scales of which are not so much erected as in the other tufts; between this and the central tufts is a blackish-brown patch which sends a streak of the same hue into the fold. The apical portion of the wing is somewhat discolored with brown, and along the inner margin, at the base of the cilia, are five or six black dots. Cilia dull testaceous. [Hind wings shiny yellowish-brown, long, narrow, lanceolate, with very long cilia] Antennæ fuscous [the basal joint long, smooth and clavate]. Head and thorax blackish-brown; labial palpi yellowish-fuscous. [Abdomen above dark brown, the joints bordered behind with gray, the terminal joint with a yellow tuft. Legs short, the tarsi only of hind pair reaching beyond abdomen; marked with gray and brown. Under surface uniform grayish-brown, the hind wings somewhat paler, and all the wings bordered with a paler line. Length 0.20; alar expanse 0.53 inch.] (After Clemens).

THE MISNAMED GALL-MOTH—*Euryptychia, saligneana*, Clemens.

(Lepidoptera, Tortricidæ.)

The only other gall-producing moth known in this country is the species illustrated herewith (Fig. 99, *a*), and there are some doubts in my mind as to whether it is a real gall-maker or an "inquiline" or intruder on my true Solidago Gall-maker (*Gelechia gallæsolidaginis.*) But two specimens of the moth have ever been found, one of which is in the cabinet of the late Brackenridge Clemens, at Philadelphia, and the other in my possession. They were both bred by Mr. Walsh from golden rod galls resembling those of my Solidago gall in being elongated and hollow; and from specimens kindly furnished to me before his death, I am enabled to give the above sketch of the dried gall, with the pupa-skin attached, and likewise that of the moth. The only description which exists of the larva is of a dead and somewhat shrunken specimen, in the following brief note taken from Mr. Walsh's journal: "Larva 16-footed, yellowish; spiracles (fuscous) on all but 2d, 3d and anal segments. Head and 2d [1st] segment horny and rufous. Length 0.40."

[Fig. 99.]



The moth is the only representative of its genus (*Euryptychia*) so far known. It was described in 1865 by Dr. Clemens * as *E. saligneana*, under the false impression that it was reared from a willow gall. But the scientific name of the insect must stand, however inappropriate.

EURYPTYCHIA SALIGNEANA—*Moth*—Front wings white, tinted with yellowish. The basal patch is dark brown. The wing beyond the basal patch is nearly white, varied with leaden-colored speckles and striped over the nervules with dull, leaden-gray, transverse stripes, two of which near the anal angle form a white ocelloid patch. Immediately interior to the ocelloid patch is a small black spot, having a line of black atoms running into it, from above and beneath. Below the apex, on the hind margin, is a triangular brown patch, which is varied with grayish and dotted with black in the middle and along the inner edge. The costa is geminated with white, and striped with brown. Hind wings dark fuscous. (After Clemens.)

Generic character—Hind wings broader than front wings. Costal and subcostal veins with a common origin; branches of subcostal connivent. Median vein 4-branched, three of which are aggregated, the two central ones from a common base. Front wings *with a broad fold*, extending to the middle of the costa, closely appressed; at least three times longer than broad; costa straight, tip moderately acute, apical margin rounded. The nervules given off from the posterior end of the cell are bent toward each other or are somewhat aggregated.

Head smooth, with ocelli at base of antennæ. Antennæ filiform, simple. Labial palpi, *do not exceed the face*, are curved, smooth, rather slender, expanded toward the tip, the apical joint scarcely perceptible, except in front. (Clemens.)

My reasons for thinking this insect an intruder on the rightful gall-maker, are: 1st, because if it were a true gall-maker we should

* Proc. Ent. Soc., Phil., V., p. 141.

naturally expect to find its gall more common; 2d, because on several occasions I have found within the *Gelechia* gall, a pale worm very different from the true gray gall-making larva. But until more decided proof can be obtained, and until the fact is settled by further experience and experiment, we must, from such evidence as we have, consider the Misnamed Gall-moth, a true gall-maker.

Thus we have three different and distinct gall-moths in this country, belonging to two distinct families and three distinct genera; while a fourth (*Cochylis hilarana*) belonging to still another genus is known to form a gall on the stems of *Artemisia* in Europe. It is very manifest that all of these galls are formed by the irritating gnawings of the larva after it is hatched, and not induced by any poisonous fluid injected with the egg by the ovipositor of the parent, as is demonstrably the case with those galls which are produced by gall-flies (*Cynips* family), and with such as are produced by some gall-making Saw-flies. It is not at all improbable, however, that these moth larvæ do in reality secrete from the mouth some peculiar fluid which tends to produce the gall; for we know that very many other moth larvæ burrow in the stems of different plants without producing any abnormal swelling.

ERRATA.

Page 13, line 25, for "cupable" read "culpable."

Page 16, line 13, for "lava" read "larva"

Page 23, line 6 from bottom, for "hole" read "holes."

Page 32, line 17, for "insect" read "insects."

Page 50, line 4 from bottom, for "*leucaiæ*" read "*leucaniæ*."

INDEX.

A

B

C

D

E

F

G

H

I

L

M

N

O

P

R

S

THIRD ANNUAL REPORT

ON THE

NOXIOUS,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY, MO.:
HORACE WILCOX, PUBLIC PRINTER.

1871.

PREFACE.

To the Members of the Missouri State Board of Agriculture:

GENTLEMEN: I herewith submit for publication, my Third Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

No particular action seems to have followed the suggestions thrown out in my last year's preface, as to the procuring of a better quality of paper and ink for these Reports. The impressions of the cuts which illustrate the text, are consequently quite inferior in my second Report, and fail to do justice to the engravings.

As will be seen from the following pages, many important discoveries in Economic Entomology have been made during the year, and some few insects have been very abundant. On the whole, however, we have enjoyed more than the usual immunity from insect depredations throughout the State. Complaints have been numerous, and articles giving extravagant accounts of the increase of noxious insects are continually appearing in our agricultural papers. But while some insects are on the increase, others are on the decrease, and the cause for alarm is in a great measure imaginary. More is now said and written about insects in the industrial journals of the State than formerly, because, through the agency of these Reports, the people have had their eyes opened to the importance of the subject; and the impression that insects generally are on the increase must be, in a great measure, attributed to this fact rather than to any real increase that has occurred.

The *American Entomologist*, in the columns of which some of the observations contained in this Report have already appeared, was continued during the year, and a botanical department, edited by Dr. George Vasey, of Normal, Illinois, was added to it. The charge of such a journal, together with my State duties, kept me too much confined, and for these and other reasons given, the magazine has been suspended during the coming year, 1871.

This suspension will enable me to spend more time in the field, and as these annual Reports have but a limited circulation, and as very many cultivators of the soil must in consequence, fail to get the information contained in them, I have concluded to devote more time the coming year to lecturing; and have already prepared for that purpose a number of large, colored illustrations.

I am satisfied that by this means I can materially add to the good effected by these Reports, and I shall endeavor to fill any engagements which the officers of our county agricultural and horticultural societies may desire to make, providing they give me notification a sufficient time beforehand.

In the following pages the same rules are complied with as were laid down in my first Report. When the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. The popular name of each insect is accompanied by the scientific name, and the latter is always printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, is also given under each heading. The dimensions are expressed in inches and the fractional parts of an inch, and the sign ♂ wherever used, is an abbreviation for the word "male," the sign ♀ for "female," and the the sign ☿ for neuter. It must also be recollected that many of the figures are magnified, and that the hair line at the side of such gives the natural size.

The scientific reader will notice that some of the insects are referred to the old instead of the more modern genera, and this course has been pursued because the generic nomenclature is constantly changing, and because the old name has often become thoroughly associated with the insect in the mind of the practical man, who would be confused by, and is not interested in, the nice changes taking place in classification.

All the illustrations in this, as in the previous Reports, have been drawn from life by myself, or under my direct care, unless otherwise stated.

I have secured a pleasant office, connected with that of your Secretary, at Room 29, Insurance Building, Southeast corner of Fifth and Olive streets, St. Louis, and all letters sent to me should be thus addressed.

My acknowledgments are due to the Superintendents of the following railroads, for free passes over their respective routes: The Pacific Railroad of Missouri, Atlantic and Pacific, St. Louis and Iron Mountain, Hannibal and St. Joseph, North Missouri, Chicago and St. Louis, Illinois Central, and the Rockford, Rock Island and St. Louis.

All which is respectfully submitted by

CHARLES V. RILEY,
State Entomologist.

ST. LOUIS, MO., December 2, 1870.

NOXIOUS INSECTS.

SNOUT-BEETLES.

(Coleoptera Curculionidæ).

AN ACCOUNT OF SOME OF THOSE SPECIES WHICH ARE INJURIOUS TO FRUITS AND VEGETABLES.

In my First Annual Report I gave an account of the common Plum Curculio, which was as complete as our knowledge of the insect would then permit. Since the publication of that Report many new and most important facts, relating to this insect, have been brought to light, and I deem it wise in this review of some of our more injurious snout-beetles, to lay these facts before the reader. Many of them were embodied in an essay read by myself at the Fifteenth Annual Meeting of the Illinois State Horticultural Society, recently held at Galesburg, in that State, and therefore, with some important additions, I reproduce that essay, which embraces the first five insects here treated of.

Insects, like other animals, derive their nourishment from the vegetable and animal kingdoms; but a glance is sufficient to show that they possess a far greater field of operations than all the other animals combined. Indeed, the food of insects is a theme so large that I might occupy page after page by dwelling upon it alone. The other animals use as food but a very small portion of the inexhaustible treasures of the vegetable kingdom, and the remainder is unpalatable or even poisonous to them. Not so with insects, for, from the gigantic *Banyan* which covers acres with its shade, or the majestic Oak, to the invisible fungus, the vegetable creation is one vast banquet, to which they sit down as guests. The larger plant-feeding animals are also generally confined, in their diet, to the leaves, seeds or stalks, being either foliaceous or farinaceous; but insects make every possible part of a plant yield them valuable provender. We have an excellent illustration of this omnipresent character of insects in those species which are well known to attack the common apple tree. Thus, beginning at the root, we find it rendered knotty and unhealthy on the outside by the common Root-louse (*Eriosoma pyri*, Fitch), while the heart is often entirely destroyed by one or the other of two gigantic Root-borers (*Prionus imbricornis*, Linn, and *P. laticollis*, Drury). The trunk is riddled by the larvæ of several Long-horn beetles, and pre-eminently by the Two-striped Saperda (*Saperda bivittata*, Say), as well as by other smaller beetles; the liber and alburnum are destroyed by the Flat-headed borer (*Chrysobothris femorata*, Fabr.), the outer bark eaten by bark beetles (*Scolytus* family) and sucked by Bark-lice peculiar to it. The branches and twigs are bored along the axis and pruned by the larvæ of the common Pruner (*Elaphidion villosum*, Fabr.), and by that of the Parallel Pruner (*E. parallelum*, Lec.), girdled by the Twig-girdler (*Oncideres cingulatus*, Say*), sawed and rasped by the Periodical Cicadas (*Cicada septemdecim*, Linn, and *C. tredecim*, Riley), otherwise known as Seventeen-year Locusts, by tree-hoppers and a dozen other Homopterous insects; bored into from the side by the Twig-borer (*Bostrichus bicaudatus*, Say), wounded by the bites of such beetles as the New York Weevil (*Ithycerus noveboracensis*, Forster), or pierced as by a red-hot wire by small boring beetles (*Scolytidæ*).

The buds before they expand are infested with the larvæ of the Apple Bud-moth (*Grapholitha oculana*, Harr.), or entirely devoured by voracious cut-worms (*Agrotis scandens*, Riley, etc.). The blossom has no sooner unfolded its delicate and beautiful petals than it is devoured entirely either by the Brazen Blister Beetle (*Lytta ænea*, Say), the Striped Cucumber Beetle (*Diabrotica vittata*, Fabr.), the Rose bug, or by a great many other insects that might be mentioned, some, as the different bees, confining themselves to the pollen or honey from the nectaries, while others again prefer other parts. The young fruit is either eaten partly or entirely by Snapping beetles (*Melanotus communis* and *M. incertus*), or punctured by either the Plum or Apple Curculios, and afterwards bored through and through by their larvæ, or by that ubiquitous Apple Worm (*Carpocapsa pomonella*); as it matures it is eaten into by the larvæ of the Plum Moth † (*Semasia prunivora*, Walsh), rendered putrid by the Apple Maggot (*Trypeta pomonella*, Walsh), and by the Apple Midge (*Molobrus mali*, Fitch); as it ripens it is gouged by the Flower Beetles (*Euryomia inda* and *E. melancholica*), and disfigured by a variety of other insects, while the skin is often gnawed off and corroded by the larvæ of the Rose Leaf-roller (*Loxotænia rosaceana*, Harr.); and even the seed, if it should be preserved, will be attacked by the Grain Sylvanus (*Silvanus surinamensis*, Linn.), the Dwarf Trogosita (*T. nana*, Melsh.) and the larvæ of one or two small moths. And as to the leaves, they are not only sapped and curled by the Apple Plant-louse (*Aphis mali*, Fabr.), and by leaf hoppers; rolled by several leaf-rollers; folded at the edges by a small pale, undescribed worm which I shall soon describe; blistered by the Rosa Hispa (*Uroplata rosa*, Weber);

*I have bred specimens of this insect from apple twigs.

†Inappropriately so called by Mr. Walsh, as I shall presently show.

crumpled by the Leaf Crumpler (*Phycita nebulo*, Walsh), mined by the Apple Micropteryx (*Micropteryx pomivorella*, Pack.); skeletonized and tied together by another undescribed worm, which I shall some day name *Acrobasis Hammondii;* but they are greedily devoured by a whole horde of caterpillars, from the tiny *Micropteryx* to the immense Cecropia worm, some of which confine themselves to the parenchyma, some to the epidermis, some to the tender parts, without touching the veins, while others bodily devour the whole leaf. The sap forms the sole food of some insects, and even when the poor apple tree dies, a host of different insects revel in its dead and decaying parts, and hasten its dissolution, so that it may the more quickly be resolved into the mold from which it had, while living, derived most of its support, and through which it is to give nourishment for the young trees which are to take its place.

Thus we perceive that there is not a single part of the apple tree which is not made to cradle, or to give nourishment to some particular insect, and the same might be said of almost every plant that grows on the face of the earth, even those which produce resinous or gummy substances, or which are pithy in the center, having special insects which feed upon these parts and on nothing else. There are insects—the gall makers, for instance—which, not satisfied with any existing part of the plants, as such, cause abnormal growths, in which their young are reared.

Nor are insects confined to vegetables in their recent state. The block of hickory wood, fifty years after it is made up into wagon wheels, is as palatable to the Banded Borer (*Cerasphorus cinctus*, Drury), which causes "powder-post," as it was to the Painted Borer (*Clytus pictus*, Drury) while green and growing; and a beam of oak, when it has supported the roof of a building for centuries, is as much to the taste of an *Anobium* as the same tree was while growing, to the American Timber Beetle (*Hylecœtus Americanus*, Harr.) Some, to use the words of Spence, "would sooner feast on the herbarium of Brunfelsius, than on the greenest herbs that grow," and others, "to whom

'——— a river and a sea
Are a dish of tea,
And a kingdom bread and butter,'

would prefer the geographical treasures of Saxton or Speed, in spite of their ink and alum, to the freshest rind of the flax plant."

Indeed, it would be difficult to mention a substance, whether animal or vegetable, on which insects do not subsist. They revel and grow fat on such innutritious substances as cork, hair, wool and feathers; and "with powers of stomach which the dyspeptic sufferer may envy, will live luxuriously on horn;" they insinuate themselves into the dead carcasses of their own class; they are at home in the hottest and strongest spices, in the foulest filth, in the most putrid carrion; they can live and thrive upon, or within the living bodies of the larger animals, or of those of their own class; they are at home in the intestial heat of many large animals, reveling in the horse's stomach, in a bath of chyme of 102° Fahr., or in the bowels of man, in an equally high temperature. Some have even been supposed to feed on minerals, and, not to dwell upon Barchewitz's tale of East India ants, which eat iron, certain it is that the larvæ of our May flies (Ephemeræ) do eat earth, and I have known the larvæ of the common May Beetle to feed for three months upon nothing but pure soil; but in both these cases the insects undoubtedly derive nourishment from the vegetable matter which is extracted from the earth by the action of the stomach.

These facts will serve to show that, seek where we may, we cannot find a place or a substance in which or on which, some insect does not feed. They people the atmosphere around us, swim at ease in the water, and penetrate the solid earth beneath our feet; while some of them inhabit indifferently all three of these elements at different epochs of their lives.

Now when we reflect that there are at least half a million—if not a full million—distinct species of insects in this sublunary world of ours, and that their habits and habitations are so diversified, it would really seem as though entomology was a subject too vast for any one man to shoulder; and indeed it is in all conscience extensive enough. The science of entomology is, however, so perfect in itself, and its classification so beautiful and simple that a particular species is referred to its Order, its Family, its Genus, and finally separated from the other species of that genus, with the greatest ease, and with a feeling of true satisfaction and triumph, by those who have mastered the rudiments of the science. And, very fortunately, it is not necessary for the practical fruit-grower to enter into the minutiæ of species or even of genera in order to learn the habits of the insects which interest him in one way or another. These minutiæ must be left to the professed entomologist.

There is not an insect on the face of the globe which cannot be placed in one or the other of seven, or more properly speaking, eight great Orders; so that, unlike the botanist, the entomologist is not bewildered by an innumerable array of these Orders, though he has five times as many species to deal with. These Orders comprise about two hundred families, many of which may, for practical purposes, be grouped into one family—as, for instance, the seven families of Digger-wasps and the five large families which have all the same habits as the true or genuine Ichneumon-flies. Many more may be neglected as small, rare, or unimportant; so that practically there will remain about a hundred family types to be learned. Each family, as Agassiz, has well remarked, may, with a little practice, be distinguished at a glance by its general appearance, just as every child with a little practice, learns to distinguish the family of A's from the family of B's, and these from the family of C's in the alphabet. There is the old English A, the German text A, and a host of ornamental A's, both in the capital letter and the small or "lower-case" letter, as the printers call it; but the family likeness runs through all, and it is astonishing how quick a child learns to distinguish each family type. It is true there are a few abnormal or eccentric insects —there were some which deceived even Linnæus—which put on the habit of strange families, just as an eel, which is a true fish with fins, puts on the habit of a snake—a reptile without fins. But these are the exceptions and not the rule.

Now it is wisely ordained that every family, as a general rule, has not only a distinctive family appearance, but also distinct family manners. For example, nobody ever saw an Ichneumon-fly construct a nest and provision it with insects, as does a Digger-wasp; and nobody ever saw a Digger-wasp deposit its eggs in the body of a living insect at large in the woods as an Ichneumon-fly does. But each family maintains its peculiar family habits, and cannot be induced to deviate from them.

So universally is this the case, that if an insect is brought me which I never saw in my life, I will tell half its history at a glance. It is this "Unity of Habits," this beautiful provision of nature—definite family likeness, accompanied by definite family habits—which so simplifies the task of the practical man; for, instead of having to study the diversified habits of half a million species, he has but to acquaint himself with the appearance and characteristics of one hundred families; and if the rudiments of Entomology had been taught in the schools of this country, so that the farmer had become familiar with these hundred family types, he would now be much better able to cope with his insect enemies. When I think that it would take a child no longer to learn these one hundred family types than it does to learn the one hundred different types which compose the four alphabets—the Roman capital and small alphabet and the writing capital and small alphabet—I fully expect, and sincerely hope, that in the public schools of this country we shall soon have text-books introduced which will cover the ground as well, and occupy the same place as do those useful works of Leunis, and Troschel and Ruthe, in the public schools of Germany.

With these few remarks, which are intended to show that the practical man may easily obtain a general knowledge of his insect friends and enemies, notwithstanding the wide field of their operations and the immense number of species which exist, we will now dwell for a while on one of these families, which deeply interest us as fruit-growers, namely:

THE CURCULIONIDÆ OR SNOUT-BEETLES.

This is one of the very largest and most conspicuous families in the Order of Beetles (*Coleoptera*), comprising, as it does, over 10,000 distinct and described species. It is at once distinguished from all the other families of beetles by the front of the head being produced into a more or less elongated snout or rostrum, at the extremity of which the mouth is situated. This snout is sometimes very long and as fine as a hair (genus *Balaninus*), and sometimes as broad as the head (genus *Brenthus*); but it always forms part and parcel of the head, and does not articulate on it as does the snout or proboscis of the true Bugs (*Hemiptera*), or the tongue of Moths and Butterflies. The other chief characteristics of the family are an apparently four jointed tarsus or foot (though in reality there are more generally five joints), an ovoid form narrowing in front, the sides pressed by the convex elytra or wing-covers, the antennæ or feelers attached to the snout, and either elbowed or straight, and composed of nine, ten, eleven or twelve joints—the first of which is always long, and the terminal three generally united in a club or knob; and finally stout legs with swollen thighs, sometimes bearing spines.

The larvæ of these snout-beetles are whitish or yellowish and fleshy grubs, usually without legs or having only in the place of them fleshy tubercles, which in a measure perform the functions of legs;* the body is oblong, with the back generally arched but sometimes straight. With these characteristics in mind, the farmer cannot fail to recognize a snout-beetle when he sees one. Now there is hardly one of the one hundred families that I have referred to from which so many injurious species can be enumerated, for with the exception of an European species (*Anthribus varius*) whose larva was found by Ratzeburg to destroy bark-lice, they are all vegetarians, the larvæ inhabiting either the roots, stems, leaves or fruits of plants; and the beetles feeding on the same. So whenever you find an insect with the characters just given, you may rest morally certain that it is injurious, and should be destroyed without mercy. This family is not only one of the most injurious, but, on account of the secretive habits of the larvæ, the insects comprising it are the most difficult to control. When a worm is openly and above board denuding our trees, we at least readily become aware of the fact, and can, if we choose, apply the remedy; but when it surreptitiously, and always under cover, gnaws away at the heart of our grains and fruits, we become in a measure helpless to defend ourselves. But even here where the enemy is so well ambushed and hidden, the proper tactics, based on thorough knowledge, will frequently enable us to penetrate the defenses and conquer the foe.

Before leaving this subject of families, let me impress upon the mind another important fact, namely, that the family is not peculiar to any one country, and that while species vary, the family has the same habits and characteristics all over the world. Thus in Europe

*It is generally unqualifiedly stated by authors that Curculionid larvæ are apodous; but there are exceptions to the rule, and I may cite as an example the larva of *Cratoparis lunatus*, Fabr., which I have found in fungi, and have bred to the perfect state, and which has six conspicuous thoracic legs.

we find the snout-beetles as injurious, and as difficult to manage—if not more so—than they are in this country. One species (*Rhynchites conicus*, Herbst.,) deposits eggs in the twigs of Pear, Plum, Cherry and Apricot, and girdles the twig to make it fall; another, (*Rhynchites bacchus*, Schœn.) infests the fruit, and still another (*Anthonomus pyri*, Schœn.) the flower bud of the Pear. One, (*Rhynchites betuleti*, F.,) rolls up grape leaves and partly cuts the stems, so that they perish, while another, (*Anthonomus pomorum*, Schœn.,) infests the blossom bud of the Apple, and renders it unfertile. Still another inhabits the blossom bud of the Cherry. *Balaninus nucum* is found in their common Hazel-nut, and *B. cerasorum* in Cherry pits; *Apion apricans* devours the seed of Clover; *Otiorhynchus sulcatus*, Schœn., infests the crown of strawberries and two different species (*Baris chlorizans*, Schœn., and *Ceutorhynchus napi*, Schœn.,) infest the stems of cabbages and turnips.

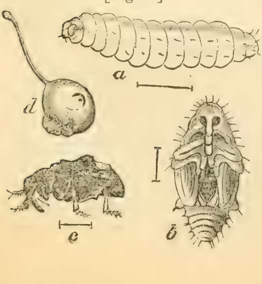
But after all, a single species—the "little Turk," for instance—sometimes causes more loss of fruit in this country than all the above enumerated species do to the European cultivator, and though much of this comparative incapacity for harm, on the part of their insects, may be in a measure due to the better knowledge of his foes which the transatlantic cultivator possesses; to the more careful culture which he pursues, and the usually limited extent of his orchard, compared with ours; yet it greatly depends on other causes, which it is not necessary now to dwell upon. So I will at once proceed to say a few words about those of our own Snout-beetles, which more particularly interest us.

THE COMMON PLUM CURCULIO—*Conotrachelus nenuphar*, Herbst.

IT IS SINGLE BROODED, AND HIBERNATES AS A BEETLE.

I shall not here repeat what has already been published about this insect; but shall confine my remarks principally to the unsettled and mooted points in its natural history, and to the new discoveries that have been made since the appearance of my first Report. I am glad to be able to say that I have forever settled the principal question, namely, as to its being single or double brooded. Authors have, from the beginning, held different views on this subject, and this fact should not surprise us, when we bear in mind that

[Fig. 1.]



they reasoned simply from conjecture; nor will it surprise us when we understand the facts in the case. The facts that fresh and soft Curculios are found in this latitude as early as the last of June, and that they still come out of the ground in August, or as late as September, and even October in more northerly latitudes, are well calculated to mislead; while it was difficult to imagine an insect living ten months before ovipositing, without dwindling away through the action of its enemies. But in the beetle state, the Curculio has few, if any enemies, and in my former writings on this subject, I have shown that the other facts do not in the least prove the insect to be double-brooded. Among those whose opinions commanded respect, from their profound entomological knowledge and general accuracy, was Mr. Walsh, who, during his last years, strenuously contended that this insect was double-brooded. For several years I have entertained a different opinion, believing that it was single brooded, as a rule, and only exceptionally double-brooded; and the facts so fully bear me out in this opinion, that were my late associate living to-day, I should bring forth the testimony with a feeling of triumph, for he was not often in the wrong! It is worthy of remark, however, that Mr. Walsh's first impression, as given by him in the year 1867*, was that this insect is single brooded; his first opinion thus coinciding with what I have now proved to be the facts in the case. In my first Report I have reviewed the experiments which led him to change his opinion, and have shown that they did not warrant his final conclusion.

The many words that have been penned in the discussion of this question would fill a volume; but one stern fact, one thorough experiment, is worth more than all the theories that were ever conceived, or the phrases that were ever written on the subject. At first it seems to be a very simple question to settle, but the fact that it remained unsettled so long would indicate the reverse. Judge A. M. Brown of Villa Ridge, at my suggestion, endeavored in the summer of 1869 to solve the problem by imprisoning the first bred beetles and furnishing them with plucked fruit. Dr. Hull partially performed a like experiment, and I did the same myself; but we were met by the advocates of the two-brooded theory with the objection that such a test was of no value, as the Curculio would not deposit on plucked fruit or in confinement; and to add weight to their argument they could cite us to numerous instances among butterflies to prove that many insects really will not deposit in confinement. But, as we shall see, they placed too much confidence in the instinct of Mrs. Turk when, from such premises, they made these deductions apply to her.

As I proved over and over again, the question could not be solved with any more certainty, by confining beetles to living boughs containing fruit, as the boughs could not well be covered with any sub-

* Practical Entomologist, Vol. II., No. 7.

stance through which the beetles would not gnaw their way out. So I determined last spring to build a frame over a large tree and entirely enclose it in stout gauze, that would neither let a flea in or out, much less a Curculio. Having accomplished this before the blossoms had fallen off the tree, I awaited with pleasurable interest the result from day to day, from week to week, and from month to month; engaging a competent person to watch, when, from necessity, I was obliged to be away. It were worse than waste of time to detail here the many interesting observations made on this tree which I had under control, or to enumerate the many other experiments which I conducted in other ways, or the innumerable facts obtained; and it will suffice to give in a summary manner the results—premising only that every precaution was taken, and no expense spared, to prevent failure; that the experiments were satisfactory beyond my expectations, the results conclusive beyond all peradventure, and that I can prove every statement I make. To sum up then:—*The Plum Curculio is single-brooded*, and I have a number now alive *which were bred during the latter part of June from the first stung peaches.* (At the time the printer is ready for this Report the beetles are still alive and flourishing—February 24th, 1871.) But, as there seem to be exceptions to all rules, so there are to this; yet the exceptions are only just about sufficient to prove the rule, for as far south as St. Louis not more than one per cent. of the beetles lay any eggs at all, until they have lived through one winter; or in other words, where one female will pair and deposit a few eggs the same summer she was bred, ninety-nine will live on for nearly ten months and not deposit till the following spring. In more northern latitudes I doubt if any exceptions to the rule will be found.

As to the other mooted point, namely, whether this insect ever hibernates under ground in the larva state, I am perfectly satisfied that it never does, but that it passes the winter invariably as a beetle, under all sorts of shelter in the woods; generally, however, near the surface of the ground. Indeed, it often makes for itself a hole in the ground, seldom however deep enough to more than barely cover its own body. In short, there is very little to alter or modify in the established facts in its natural history, which I have already published. The egg, instead of being "oval," as there stated, would be better described as "oblong-oval," measuring exactly 0.03 inch in length, and being nearly three times as long as wide. It should also be remarked here, that when depositing the eggs in apples, the female often neglects the usual symbol of Mohammedanism, which she so invariably inscribes upon stone fruit; and that where this mark is made on apples, it more easily becomes obliterated.

During their beetle life, these insects feed continually, just as long as the weather is mild enough to make them active. While fruit lasts, they gouge holes in it, and after peaches have gone, apples are badly attacked. They also gnaw large holes in the leaves, and when nothing else presents, will feed on the bark of the tender twigs.

The beetles often make a peculiar creaking noise (a fact not mentioned before of this species) by rubbing the tip of the abdomen up and down against the wing-covers.*

Let us be thankful, therefore, that there can no longer reasonably be difference of opinion, or discussion on these questions, which, though of no very great practical importance, were yet of great interest to us all.

IT IS NOCTUNRAL RATHER THAN DIURNAL.

Before leaving this little Turk, however, I have some other facts to mention which were first brought to light the present year, and which have a most important practical bearing. The people of the West have been repeatedly told, and with so much assurance that they no doubt have all come to believe it as gospel, that Curculios fly only during the heat of the day, and that it is useless to endeavor to catch them after say 10 o'clock in the morning. What I am about to utter will no doubt astonish many, but I know whereof I speak. *The Curculio is a nocturnal rather than a diurnal insect; is far more active at night than at day, and flies readily at night into the bargain.* If any one doubts this assertion, let him go into his peach or plum orchard at midnight with a lantern and sheet, and he will catch more than he could during the day, and will also find, to his sorrow, that they are then much more nimble and much bolder—

*A great many different beetles belonging to widely different families have the power of making a stridulating creaking noise, and though the instrument is found upon different parts of the body in different species, yet it is always made after one plan, namely, a file-like rasp and a scraper. In Darwin's new book (Descent of Man, pp. 366–73) an interesting account of the different methods employed will be found. Every entomologist knows how commonly this creaking noise occurs in the Long-horn beetles, and that the rasp is situated on the mesothorax and is rubbed against the prothorax. In the Burying beetles (NECROPHORIDÆ) these rasps are situated on the fifth abdominal joint, and are scraped by the posterior margin of the elytra. In the Dung-beetles again it is variously situated upon different portions of the body. Dr. Fitch (10th Ann. Rep. p. 12) has noticed the creaking noise made by the Three-lined Leaf-beetle (*Lema trilineata*) which is produced by the same motions as those witnessed in our Curculio; but in this instance, as in all other stridulating Chrysomelidæ, the rasp is situated on the dorsal apex of the abdomen known as the pygidium, and is scraped by the wing-covers; while in the closely allied Curculionidæ which have this power the parts are completely reversed in position. Any one who will take the trouble to carefully examine the wing-covers of our Plum Curculio will find on the lower apical edge of each, a horny, slightly raised plate, about a third as long as the whole wing-cover, and transversely and obliquely ribbed by numerous parallel ridges. There is also a longer cord or carina near the sutural edge which may help to intensify the noise. The dorsal apex of the abdomen or pygidium forms a yellowish and roughened plate, with the sides horny and emarginate, so that when the abdomen plays up and down, these horny edges grate or scrape at right angles against the rasp.

In some instances the stridulation is possessed principally by one sex and serves no doubt as a sexual call; but with our Curculio as with most other stridulating beetles, both sexes seem to share alike in the power, and it then no doubt serves as a mutual call, or is used under the influence of distress, fear, or even pleasure; for I have always more particularly noticed the noise of an evening when the Curculios were most active and preparing for their active night work.

scarcely feigning death at all. Indeed, with the exception of such females as are busily occupied in depositing eggs, most of the Curculios rest during the day, sheltered either by the foliage or branches of the tree, or by any extraneous substance on the ground near by. They are also more active in the evening than in the morning, and these facts lead us to the important question, whether the morning or the evening is the best time to jar the trees. My experiments so far are not conclusive, for I have some days caught more in the morning, and at others more in the evening. All other things being equal, the evening will prove preferable to the morning, from there being less dew at that time; and I particularly draw attention to this matter now, that the proper experiments may be instituted during the coming year by more than one individual.

THE RANSOM CHIP-TRAP PROCESS.

Another grand and successful mode of fighting the little Turk was also brought to light again, and to a great extent practiced the past summer. I allude to the Ransom chip process for entrapping this insect. About the middle of May the Horticultural world was startled by a somewhat sensational article, which was the burden of an extra to the St. Joseph (Michigan) *Herald*, headed :—"Great Discovery—Curculio Extermination Possible." The process consists in laying close around the butt of the tree pieces of chips or bark, under which, according to their instinct, a great many of the Curculios secrete themselves during the day, and may thus be easily destroyed. Now that we better understand this insect's habits, we also better comprehend the philosophy of this process. Being noctural in their habits, the beetles naturally seek shelter during the day, and especially is this the case early in the season, when the days are chilly, and before the females are too much engaged in egg depositing. Numerous opinions were expressed as to the value and efficiency of this method; but I will here repeat my own, as given to the readers of the *American Entomologist and Botanist;* first, because I endeavored to be candid and truthful, and secondly, because the opinions expressed have been so far fully corroborated by subsequent experience. Let it be distinctly understood that in recording what I believe to be the facts in the case, I have no wish to detract one particle from the credit due Mr. Ransom, for bringing this method prominently before the people, and demonstrating its practical applicability; for to him undoubtedly belongs the honor of the re-discovery and of the proper application of the method:

"We are really sorry to damp the ardor and enthusiasm of any person or persons, when enlisted in such a good cause, but truth obliges us to do so, nevertheless. Of course Curculio extermination is possible! but not by the above method alone, as our Michigan friends will find to their sorrow. For a short time, early in the season, when the days are sometimes warm and the nights cold, and before the peach blossoms have withered away, we have succeeded in capturing Curculios under chips of wood and in other such sheltered situations; but we have never been able to do so after the fruit was as large as a hazlenut, and the little Turk had got fairly to work. Our Michigan friends will, we fear, find this to be too truly the case.

"This process, furthermore, cannot well be called a new discovery, because it was discovered several years ago, as the following item from Moore's *Rural New Yorker* of January 28th, 1865, will show:

"HOW TO CATCH CURCULIO.—In May last we had occasion to use some lumber. It was laid down in the vicinity of the plum yard, and on taking up a piece of it one cold morning, we discovered a number of curculios huddled together on the under side. On examining other boards we found more, so we spread it out to see if we could catch more, and we continued to find more or less every day, for two weeks. We caught in all one hundred and sixty-one. So I think if people would take a little pains they might destroy a great many such pests. These were caught before the plum trees were in flower. What is most singular is, that we never found a curculio on a piece of old lumber, although we put several pieces down to try them. They seemed to come out of the ground, as we could find them several times a day by turning over the boards.

Johnsonville, New York. MRS. H. WIER.

"But though Mr. RANSOM cannot properly claim to have made a new discovery, and although this mode of fighting will not prove sufficient to *exterminate* the Curculio, yet we greatly admire the earnestness and perseverance which he has exhibited. In demonstrating that so great a number of the little pests can be entrapped in the manner described, Mr. R. has laid the fruit growers of the country under lasting obligations to him. It is a grand movement towards the defeat of the foe, and one which, from its simplicity, should be universally adopted early in the season. But we must not relinquish the other methods of jarring during the summer, and of destroying the fallen fruit; for we repeat that the Plum Curculio will breed in the forest."

I subsequently visited St. Joseph, for the express purpose of examining more closely into Mr. Ransom's Curculio remedy. I found that so few Curculios had been caught under the chips after the first week in June, that nearly everybody, except Mr. Ransom, had for some time abandoned the method, and were jarring their trees by one process or another. Mr. Ransom himself, by dint of unusual perseverance and great care in setting his traps, had much better success than I had expected he would. On the 15th June he caught 78; on the 16th, 97; and on the 17th, 71. For about a week after this he scarcely caught any, but from the 24th to the 27th inclusive, he caught about 300. On the 6th of July I accompanied him around the outside rows of his orchard and caught five under the traps. We had no opportunity to use the sheet, but I am satisfied that more could have been jarred down. Mr. R. had a very fair crop of peaches, and—forgetting that crops have often been grown before with very little care, and that others around him who did not bug so persistently had fruit also this year—is very sanguine of his new method, and too much inclined, perhaps, to attribute his crop solely to this remedy. Nevertheless, contrary to the impression made by his published views, he was candid enough to admit that it might be found necessary to resort to the jarring process, after a certain season of the year; and indeed the number of stung peaches on the ground showed too plainly that there is no hope of *extermination* by the chip plan alone. The soil around St. Joseph is, for the most part, a light sandy loam, never packing, and very easily kept in good cultivation. To this character of the soil must be attributed much of the success with the Ransom method; for I am satisfied, after full experiment, that in the warmer climate and heavier soil of St. Louis, it is of no practical use after the middle of May, or at the farthest, after the first of June. The few specimens that I have captured by this method at St. Louis were found under small pieces of new shingle; and Mr. W. T. Durry, who has 2,300 trees in his orchard at St. Joseph, also found this the best kind of trap. Mr. Ransom, however, prefers small pieces of oak bark, which he places close around the tree, with the inner or concave side pressed to the ground. Stones do not answer well, and corn cobs are objectionable because it requires so much time to discover and destroy the Curculios, which hide in their deep cavities.

The best time of day to take the Curculios from under the chips is undoubtedly in the afternoon; but it must not be left too long, as they begin to leave and scatter over the trees as soon as the sun approaches the horizon. The chips should be laid around the trees as soon as the frost is out of the ground, or at least by the time the blossoms begin to expand; for more beetles will be caught under them during a few weeks thus early in the season than throughout the rest of the year.

Before concluding this branch of the subject, I earnestly urge upon fruit-growers throughout the State to give this process a good trial during the coming season, and to report the results to me. The observations of a hundred persons in as many different parts of the State must necessarily be of more value than those of a single individual in any one locality; and as the process was not prominently brought before the public last year, until it was too late to make thorough experiments, it is very desirable to have the true value of the method in Missouri definitely ascertained in 1871. To arrive at such definite knowledge of its value, I need the co-operation of intelligent fruit-growers, and for this reason I hope that notes and experiments will be made and sent to me at my office, any time during the summer. The number of trees experimented on, number of beetles captured, time of year, hour of day, character of soil, and all other facts connected with the experiments should be noted; as they all help us to a more thorough knowledge of the true value of the process

KEEPING IT IN CHECK BY THE OFFER OF PREMIUMS.

After visiting St. Joseph and vicinity, I passed into Ontario, where I found the trees overloaded with fine unblemished fruit. I found my friend, Mr. Wm. Saunders, of London, also much occupied with, and interested in, the Curculio question. He was, in fact, carefully counting different lots of this insect which had been received from different parts of the Dominion; for be it known, that the enterprising Fruit-Growers' Association of Ontario, in its praiseworthy efforts to check the increase of the Curculio, offered *a cent per head* for every one which should be sent to our friend, who happens to be secretary of that body. What would our own people think if the Legislature or the State Horticultural Society should offer an equally liberal premium *per capita* for every little Turk captured? Wouldn't they set about capturing them in earnest, though! The Legislature might stand it, and I am not sure but that some such inducement, held out by the State to its fruit-growing citizens, would pay, and prove the most effective way of subduing the enemy. But the Horticultural Society that should undertake it, would have to be pretty liberally endowed. Just think of it; ye who catch from three to five thousand per day. The bugs would pay a good deal better than the peaches. However, very fortunately for the Ontario Fruit-Growers' Association, their good offer did not get noised abroad as much as it might have been, and the little Turk occurs there in such comparatively small numbers, that up to the time I left only 10,731 had been received.

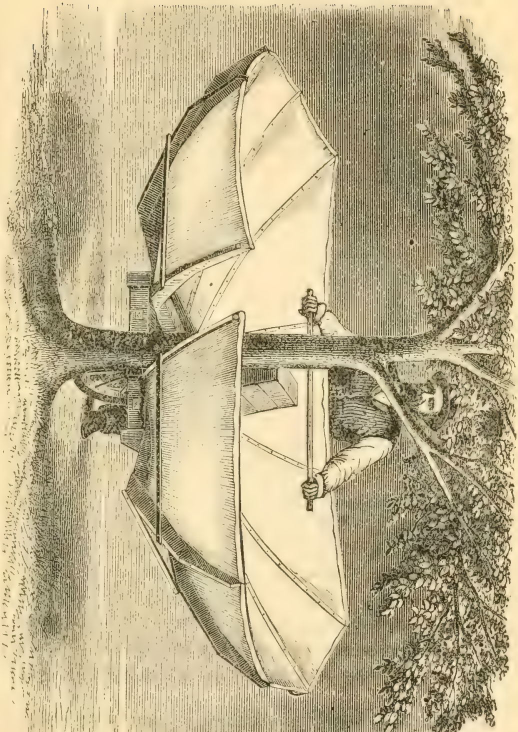
PARIS GREEN AS A REMEDY.

Mr. G. M. Smith, of Berlin, Wisconsin, in an article written last fall to the St. Joseph (Mich.) Horticultural Society, recommends Paris Green for the Plum Curculio. Even if the uniform application of such a poisonous drug on large trees were practicable, it would never succeed in killing one Curculio in a hundred. Paris Green kills the leaf-eating beetles by being taken internally with the leaves; but the Curculio, with its snout, prefers to gouge under the skin of the fruit, and only exceptionally devours the leaves. Yet, notwithstanding the palpable absurdity of the remedy, it has very generally passed from one journal to another without comment.

JARRING BY MACHINERY.

Of course there is no more expeditious way of jarring down the Curculio than by the Hull Curculio-catcher (Fig. 2.) Yet I confess that after extensive observations in many different parts of the country I am forced to the conclusion that this machine does not give the satisfaction one could wish. I have already shown that where it was constantly used the trees suffered serious injury from bruising, and it is a rather significant fact that in most orchards where it has been introduced, some modification has soon followed, or else it has been entirely abandoned; while in the East they still adhere to the improved stretchers and mallet. It seems to me that the machine, as made by Dr. Hull, two years ago, was not only too heavy and unwieldy, but incapable of giving the requisite sharp jarring rap to the branches of a large tree without causing too much injury to the trunk; and that if a modification of it could be made to satisfy the peach-grower, there would soon be a greater demand for such a machine.

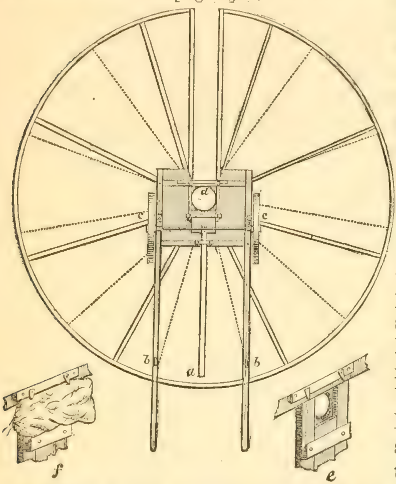
[Fig. 2.]



[A full description of this machine, without any figure, was given in my first Report, pp. 60-61.]

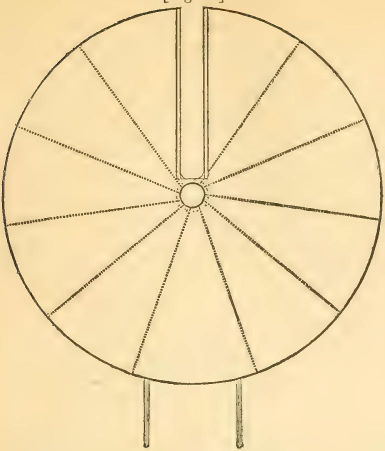
As a step in the right direction I will briefly describe a machine which I have herewith illustrated, (Fig. 3, back view; Fig. 4, front view), and which I found in quite general use around St. Joseph and Benton Harbor, Michigan. It was gotten up by Mr. L. M. Ward of the latter place, and proves, in the orchard, to have decided advantages over the Hull machine, of which it is a modification. It is a much lighter machine, and, as the diagrams indicate, instead of running on a single wheel it is carried and balanced by two, (Fig. 3, *c c*) and supported with legs on the handles, (Fig. 3, *b b*), when not running. The Curculios and stung fruit are brushed through a hole in the centre (Fig. 3, *d*), and as the operator passes from one tree to another he closes this hole, to prevent the beetles from escaping, by means of a slide, (Fig. 3, *a*), which he has under control. Bags previously prepared, by being fastened on a square piece of wood with a hole in the centre corresponding to a hole in the side of the bag, are snugly buttoned below (Fig. 3, *e* and *f*), so as to secure everything that falls through from above, and when one bag is full it is easily replaced by another, and its contents destroyed by scalding, or otherwise, and emptied out. In most of the orchards where this machine was being used, the jarring was performed by a separate mallet, which is easily hung, as is also the brush, on the shafts when the machine is being operated by one person, or, which I think a better way, where help is not scarce, it can, with the brush, be carried by a second person (an intelligent boy will answer,) who performs the jarring and brushing while the first person wheels the machine.

[Fig. 3.]



The machine is simple in construction, and any one with ordinary mechanical ability can build it—modifying, of course, the diameter of the wheels and the inclination of the sheet to suit the character of his trees or of his ground. Mr. Ward has taken no patent out for it, and the machine is, therefore, public property. The platform may be made narrower than shown in the illustration, for the nearer the wheels approach and the lighter the machine, the better. It has been argued in favor of the one-wheel machine, that it can be more easily

[Fig. 4.]



run on rough ground and more readily turned, which, in a great measure, is true; but the Ward machine might be so made that it could easily be tilted on one wheel in turning, and our Benton Harbor friends have so far found no difficulty in operating it. The two wheels have the additional advantage that the machine is not rendered unwieldy by strong wind. It also stands firm when left by the operator, who is thereby better enabled to use a mallet if he prefers it, the mallet being hung to the shafts, and taken down after the machine is wheeled into position. Either machine can be used with a bumper, or with a mallet, and there are certain rules which should be adopted in jarring for the Curculio, no matter whether a one-wheel or a two-wheel machine is used. These rules are: First. In jarring with a mallet, it is best to prepare each tree by squarely sawing off some particular limb, or else the mallet must be well protected with rubber to prevent bruising of the tender bark. The former custom is by far the best, as we are enabled to give the tree a sharp, vibrating rap with the bare, hard wood. Secondly. If the mallet is dispensed with, and the tree is bumped with the machine—a method which certainly has the advantage of expedition—it will be found altogether more profitable to drive a shouldered spike or to insert a shouldered screw in the trunk at the right distance from the ground, and the jarring can then always be done on this spike without injury to the tree.

If the trees are headed high enough to admit of a sufficient inclination of the canvas, the beetles will naturally roll to the centre and fall into whatever receptacle there may be for them below; but such an inclination is not often practicable, and the brush or broom is almost always needed.

The orchardist must also be guided in his choice of machines by the character of his land, for the two-wheel machine doubtless owes much of its success around St. Joseph, Michigan, to the smoothness of their land. No machine will work well on rough, cloddy soil.

There are various improvements that might be made in the above machine by any ingenious person, and at my suggestion Mr. J. E. Porter of the Eagle Agricultural Works, Ottawa, Illinois, has commenced building these two-wheel machines with adjustable arms. The canvas also is to be so made that it can be fastened on and taken off again so that the whole may be more compactly packed for shipping, and for storing away out of the wet. Exclusive of the canvas, the whole can be made ready for shipment for from $16,00 to $18,00, and the machine will no doubt be advertised the coming season.

It is gratifying to know also that the inventive genius of some of our Western men is being applied to the improvement of this implement. Thus Messrs. Claxton & Stevens of the Insane Asylum, St. Louis county, have just applied for a patent on a one-wheel machine, the principle feature of which is a bumper which works with a spring.

[Fig. 5.]

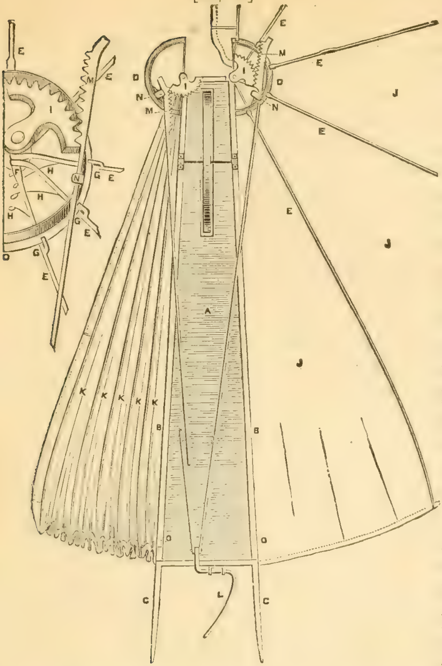
I have seen the model, but am not favorably impressed with the machine as one having any great practical value. The spring bumper is an expensive and unnecessary addition, and in other respects the machine is inferior in utility to that I have just described. One good feature, however, is an arrangement for closing up the tree-way where the bumper touches the tree. It consists simply of two long strips of sheeting fastened to a light frame, each one of which is so attached to the sides of the tree-way that when dropped they form a roof as at Figure 5. The tree easily separates these two pieces when the machine is worked. The frame of this machine is quite flat with an upturned rim, but each half-circle is so arranged that it can be raised on hinges.

Dr. M. M. Hooten, of Centralia, Illinois, patented last summer a machine made very much after Dr. Hull's plan, but he has since made several improvements and changes and has made application for another patent for the improved machine which I herewith illustrate from a model with which he has kindly furnished me.

He first constructs a long narrow wheel-barrow with a level and smooth platform (Fig. 6, *a*,) made of ½ inch pine or other light material, firmly nailed down to two arms (*b*, *b*,) and covering them from the front end to within twenty inches of the rear end. These rear ends serve for handles (*c*, *c*). The anterior ends, at a point one foot from the extremity, rest upon the axles of the wheel, which is two feet in diameter. He then attaches a half circle (*d*, *d*) to each outer side of the forward ends of the arms of the platform. These half circles are ten inches in diameter, and are so placed as to be about two-thirds of their width in advance of the platform, which at the forward end is from ten to twelve inches wide. Thus enough room is left for the tree to be admitted between the flat sides of the half circles.

There are now to be five or six movable arms (*e*, *e*) placed on each side of these iron half circles, and a single half-inch bolt (*f*) passed through a hole in the inner ends of them, and through the straight bar next to the tree-way. The arms are now permitted to rest on the half circles, and are held down to the circle by a hook

[Fig. 6.]



which is attached to the lower side of the arm and curves over the outside of, and under, the circle (*g*, *g*).

These movable arms are now arranged at equal distances on the circles, and fastened with twine, while the canvas is being tacked on, beginning first by tacking it to the sides of the platform of the barrow and then to the arms. At the inner end of each of these movable arms is a raised finger (*h*, *h*), which holds the canvas up so as to keep any insects from being thrown over into the tree-way. A semi-circular cog-wheel (*i*, *i*), which works by its centre, is now placed on the lower end of the same bolt that passes through the inner ends of the movable arms. The forward arm on each side is firmly attached to this cog-wheel, which works under the canvas. When made to revolve backwards or forwards on the bolt, this cog-wheel carries the outside arm around on the iron half circle, and the sheet-covered frame is thus easily stretched and opened, as at *j*, *j*, or closed as at *k*, *k*.

This motion is quickly accomplished by means of a lever (*l*), which works on a hinge at the rear of the platform, and which moves a rod armed on one side at the forward end with cogs (*m*, *m*), which tread in the cogs of the semi-circular cog-wheel before described, to which it is held by a keeper (*n*). The handle of the lever lies on the platform when the machine is folded, and stands upright when it is extended; so that by a single motion of one hand of the operator, the machine may be folded into a very small compass, or as quickly extended. The hinder part of the machine is supported by two swinging legs (*o*, *o*). These may swing back to the handles, but cannot go forward beyond a right angle. The machine is very light, and works so easily that, according to the inventor, a boy of fourteen years can easily run one of them. The whole machine does not weigh over forty pounds.

The above figure represents a back view of the machine, with one side open and the other closed. The principle advantage of the machine lies in this folding apparatus, which enables the operator to defy the wind which on some days renders the original Hull machine almost useless as it plays powerfully against the stretched canvas. This feature also enables the owner to store the machine away with less trouble. I have my doubts, however, whether the advantage gained sufficiently compensates for the extra machinery. Another advantage which Mr. Hooton claims for the machine is that it is so low that it will swing its broad folds under low-headed trees. That portion of the wheel which rises above the platform is protected by a circular box, and it is found that every time the canvass is expanded, there is a slight jerk, which casts everything that has fallen upon it to the centre, where the bugs and fruit consequently remain until removed. The raised fingers to which the canvas is attached at the centre, and similarly raised pieces along each side of the tree-way, prevent the insects and fallen fruit from escaping; and there is no receptacle below into which they can be brushed. The machine is therefore built with the idea that it is as easy to pick up and remove the fallen beetles and fruit as it is to brush them into a receptacle below.

In operating the machine it is wheeled up to the tree while closed, then expanded and drawn back a little so as to give the tree a jar, and then closed and wheeled away to the next tree. Mr. Hooton has had a full sized machine in operation, and it seems to give very good satisfaction. As there is considerable casting needed, the ordinary fruit-grower will not be able to manufacture it as easily as he can the Ward machine; but as all these machines will doubtless be put upon the market the coming season, the reader must choose for himself which he prefers.

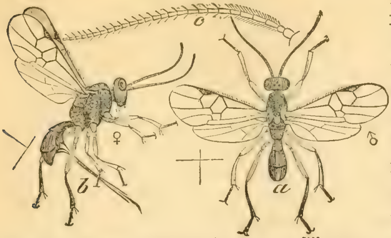
I have been urged to take an interest in two of these machines, and even to take out a patent for certain improvements suggested; but as a public officer I have refused to do either. My object is to give a disinterested and candid account of what I conceive to be the merits or demerits of any machine that may appear, in the hope that ere long we shall have something in the market, so cheap and efficient that no peach-grower will have any excuse for not jarring his trees.

TWO TRUE PARASITES OF THE PLUM CURCULIO.

THE SIGALPHUS CURCULIO PARASITE.

Just 10 years ago, in his "Address on the Curculio," delivered at the annual meeting of the N. Y. State Agricultural Society, Dr. Fitch gave an account, accompanied with a figure, of a small Ichneumon-fly which he named *Sigalphus curculionis*, and which he believed was

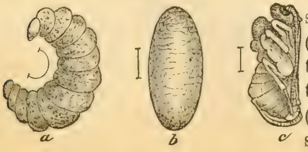
[Fig. 7.]



parasitic on the Curculio. Before that time no parasite had ever been known to attack this pestilent little weevil, and even up to the present time it is currently believed that no such parasite exists; for unfortunately the evidence given by Dr. Fitch was not sufficient to satisfy some of our most eminent entomologists. These parasites were in fact received by him from Mr. D. W. Beadle of St. Catherines, C. W., who had bred them from Black-knot, from which he bred at the same time a certain number of Curculios; but as other worms besides those of the Curculio are likewise found in Black-knot, we had no absolute proof that this fly was parasitic on the insect in question. Consequently we find that Mr. Walsh, in his Report as Acting State Entomologist of Illinois, rather ridicules the idea of its being a Curculio parasite and endeavors to prove that it is parasitic instead on the larva of his Plum Moth (*Semasia prunivora*). But I have this year not only proved that poor Walsh was himself wrong in this particular inference, but that he was equally wrong in supposing his little Plum-moth, so called, to be confined to plums; for I have bred it from Galls (*Quercus frondosa*, Bassett); from haws, from crab apples and abundantly from tame apples.

To be brief, Dr. Fitch's *Sigalphus* is a true parasite on the Plum Curculio and I have bred hundreds of the flies from Curculio larvæ. The first bred specimens gave me much pleasure, for as soon as I saw they belonged to the same genus as Dr. Fitch's fly, I felt assured that another disputed question was settled. But to make assurance doubly sure, I repeatedly half filled large jars with pure earth, finely sifted so that no living animal remained in it. Into these jars I placed Curculio larvæ from day to day as they issued from peaches that were thrown into another vessel, and in due time the parasitic flies began to issue from the ground along with the perfect Curculios. Nay more than this, I soon learned to distinguish such Curculio larvæ as were parasitised, and after they had worried themselves under the ground—seldom more than half an inch—I would uncover them, and on several occasions had the satisfaction of watching the gnawing worm within reduce its victim until finely nothing was left of him.

[Fig. 8.]



As soon as the Curculio larva is destroyed by the parasite, the latter (Fig. 8, *a*) encloses itself in a tough little yellowish cocoon of silk (Fig. 8, *b*), then gradually assumes the pupa state (Fig. 8, *c*) and at the end of about the same length of time that the Curculio requires to undergo *its* transformations and issue as a beetle, this, its deadly foe, gnaws a hole through its cocoon and issues to the light of day as a black four-winged fly (Fig. 7, *a male; b female*). In the vicinity of St. Louis, this fly was so common the past season that after very careful estimates, I am satisfied three-fourths of all the more early developed Curculio larvæ were destroyed by it. On the 17th and 18th of April, in that locality a severe frost killed the peach buds on all but a few of the young and most vigorous trees of Hale's Early and Crawford, so that instead of a large and abundant crop of peaches to depredate on, the little Turk had to concentrate its attacks on the few peaches that were left; and no one expected that any fruit would be saved. Yet the work of this little parasite was so effectual that, wherever fruit set, a fair crop was gathered even by those who made no effort at all to protect their trees!

While visiting Dr. Fitch last August, at his house in Salem, N. Y., I compared my bred specimens with his species, and found them identically the same; but a full description of it will be found below, and it is not necessary at present to dwell upon its characters.

As Mr. Walsh bred this same parasite from the larvæ of his little Plum Moth, it doubtless attacks other soft-bodied larvæ and does not confine itself to the Plum Curculio. This is the more likely as it would scarcely pass the winter in the fly state. The female, with that wonderful instinct which is exhibited in such a surpassing degree in the insect world, knows as well as we great Lords of Creation what the little crescent mark upon a peach or plum indicates; and can doubtless tell with more surity, though she never received a lesson from her parents, whether or not a Curculo larva is drilling its way through the fruit. When she has once ascertained the presence of such a larva by aid of her antennæ—which she deftly applies to different parts of the fruit, and which doubtless possess some occult and delicate sense of perception, which, with our comparatively dull senses, we are unable to comprehend—then she pierces the fruit, and with unerring precision, deposits a single egg in her victim, by means of her ovipositor.

Now there is, as I shall show in the description, a variety (*rufus*) of this parasite, with the ovipositor nearly one-fifth of an inch long, but in the normal form the ovipositor is only twelve-hundredths of an inch long, and the Curculio larva must therefore be reached soon after it hatches, or while yet very young. Consequently we find that the earliest Curculio larvæ, or those which hatch while the fruit is yet small, are the most subject to be parasitised, and while from larva obtained early in the season, I bred more parasites than Curculios, this order of things was reversed a little later in the year. Some persons will no doubt wonder how such a large fly can be developed from a Curculio larva which is stung while so young; but we do not know how long the parasitic egg remains unhatched, and it must be remembered that it is a rule, wisely ordained and long known to exist in insect life, that the parasitic larva does not at first kill outright, but subsists, without retarding growth, upon the fatty portions of its victim, until its own growth is attained. Thus the first worm derives its nourishment from the juicy fruit, and grows on regardless of the parasite which is consuming its adipose substance, until the latter is sufficiently developed, and the appointed time arrives for it to destroy its prey by attacking those parts more vital.

This parasite, which I will now proceed to describe, belongs to the second sub-family (*Braconides*) of the Ichneumon-flies (*Ichneumonidæ*), and the venation of its wings, and 3-jointed abdomen, place it in the genus *Sigalphus*. Westwood (Synopsis, p. 63) gives three cubital panes or areolets in the front wings as characteristic of the genus; but Brullé (p. 510) and, as Mr. Cresson informs me, Westmael in his *Braconides de Belgique*, give only two, which is the number in our insect.

SIGALPHUS CURCULIONIS, Fitch—*Imago*—(Fig. 7, *a* male; *b* female). *Head* black, sub-polished and sparsely covered on the face with short whitish hairs; ocelli touching each other; labrum and jaws brown; palpi pale yellow; antennæ (Fig. 7, *c*) 27-jointed, filiform, reaching, when turned back, to middle joint of abdomen or beyond, the bulbus and small second joint rufous and glabrous, the rest black or dark brown, though 3–10 in many specimens are more or less tinged with rufous; 3–14 very gradually diminishing in size; 14–27 sub-equal. *Thorax* black, polished, the metathorax distinctly and broadly punctate, and the rest more or less distinctly punctate or rugose, with the sides sparsely pubescent. *Abdomen* pitchy-black, flattened, the dorsum convex, the venter concave, and the sides narrow-edged and slightly carinated; the three joints distinctly separated and of about equal length; the first joint having two dorsal longitudinal carinæ down the middle; all densely marked with very fine longitudinally impressed lines, and sparsely pubescent; (Dr. Fitch in his description published in the *Country Gentleman*, under date of September, 1859, states that these lines leave "a smooth stripe along the middle of its second segment and a large smooth space on the base of the third;" which is true of a few specimens, but not of the majority, in which the impressed lines generally cover the whole abdomen.) Ovipositor longer than abdomen, but when stretched in a line with it, projecting backwards about the same length beyond; rufous, with the sheaths black. *Legs* pale rufous, with the upper part of hind tibiæ and tarsi, and sometimes the hind femora, dusky. *Wings* subhyaline and iridescent, the veins pale rufous, and the stigma black. Length ♀, 0.15–0.16 inch, expanse 0.30; ♂ differs only in his somewhat smaller size and in lacking the ovipositor. In many specimens the mesothorax and the eyes are more or less distinctly rufous.

Described from 50 ♀♀, 10 ♂♂, bred June 23d–July 29th, 1870, from larvæ of *Conotrachelus nenuphar*, and 2 ♀♀ obtained from Dr. Fitch.

Larva (Fig. 8, *a*)—White, with translucent yellowish mottlings.

Pupa (Fig. 8, *c* ♀)—0.17, inch long; whitish, the members all distinct, the antennæ touching hind tarsi, the ovipositor curved round behind, reaching and touching with its tip the third abdominal joint, which afterwards forms the apical joint of imago; five ventral joints, which in the imago become much absorbed and hidden, being strongly developed.

Cocoon (Fig. 8, *b*)—Composed of one layer of closely woven yellowish silk.

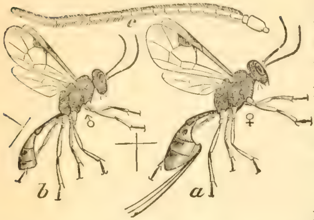
VARIETY RUFUS—Head, thorax and most of first abdominal joint entirely rufous, with the middle and hind tibiæ dusky, and the ovipositor three times as long as abdomen and projecting more than twice the length of the same beyond its tip.

Described from three ♀♀ bred promiscuously with the others. This variety is slightly larger and differs so remarkably from the normal form that, were it not for the absolute correspondence in all the sculpturing of the thorax and body, and in the venation of the wings, it might be considered distinct. The greater length of the ovipositor is very characteristic, and accompanies the other variation in all three of the specimens.

THE PORIZON CURCULIO PARASITE.

The other parasite works in very much the same manner, but instead of issuing the same summer as a fly, it remains in its somewhat tougher and more yellowish cocoon all through the fall and winter, and does not issue in the winged state till the following spring. This parasite was first discovered by Dr. Trimble, who sent me the cocoons from which I subsequently bred the perfect fly. It belongs to the first sub-family (*Ichneumonides*) of the Ichneumon-flies, and apparently to the genus *Porizon** of which it forms a new species. It is only necessary here to state that it differs from the other species in its reddish-brown abdomen, as well as in form, as may be readily seen by referring to the figures (Fig. 9, *a* female; *b* male; *c* antenna).

[Fig. 9.]



PORIZON CONOTRACHELI, N. SP.—*Head* pitchy-black, opaque, the ocelli triangularly placed and close together; eyes oval, polished, and black; face covered with a silvery-white pubescence; labrum rufous, with yellowish hairs; mandibles and palpi, pale yellowish-brown; antennæ inserted in depressions between the eyes, reaching to metathorax when turned back, filiform, 24-jointed; black with basal joints 6–1 becoming more and more rufous, the bulbus always distinctly rufous; bulbus rather longer and twice as thick as joint 3; joint 2 about one-third as long. *Thorax* pitchy-black, opaque, the sides slightly pubescent with whitish hairs, the mesothorax rounded and bulging anteriorly, the scutellum slightly excavated and sharply defined by a carina each side; metathorax with the elevated lines well defined and running parallel and close together from scutellum to about one-fourth their length, then suddenly diverging and each forking about the middle. *Abdomen* glabrous, polished, very slender at base, gradually broader and much compressed from the sides at the apex which is truncated; peduncle uniform in diameter and as long as joints 2 and 3 together; joints 2–5 subequal in length; color rufous with the peduncle wholly, dorsum of joint 2, a lateral shade on joint 3, and more or less of the two apical joints superiorly, especially at their anterior edges, black; venter more yellowish: ovipositor about as long as abdomen, porrect when in use, curved upwards when at rest, rufous, with the sheaths longer and black. *Legs,* including trochanters and coxæ uniformly pale yellowish-brown with the tips of tarsi dusky. *Wings* subhyaline and iridescent, with veins and stigma dark brown, the stigma quite large, and the two discoidal cells subequal and, as usual in this genus, joining end to end, but with the upper veins which separate them from the radial cell, slightly elbowed instead of being straight, thus giving the radial cell a quadrangular rather than a triangular appearance. ♂ differs from ♀ only in his somewhat smaller size and unarmed abdomen. Expanse ♀ 0.32 inch, length of body, exclusive of ovipositor 0.22; expanse ♂ 0.28, length 0.18.

Described from 3 ♀ ♀, 1 ♂ bred May 26th–28th, 1870, from cocoons received from Dr. I. P. Trimble, of New Jersey, and 1 ♀ subsequently received from the same gentleman—all obtained from larvæ of *Conotrachelus nenuphar.*

"But of what use are these parasites?" say you! Well, they can not, it is true, be turned to very practical account, because they are not sufficiently under our control; but it is a source of great satisfaction to those who have been looking for many years for some natural aid to help them in the artificial warfare waged against the Curculio,

* As I am informed by Mr. E. T. Cresson, of Philadelphia, who pays especial attention to the classification of the *Ichneumonidæ*, it might more properly be referred to Holmgren's genus *Thersilochus*, which differs from *Porizon* in the greater distance between the antennæ at base, and in the venation of the wing.

to know that besides its several cannibal foes, there are at last two true parasites which attack it. Indeed, with the knowledge of the Curculio enemies figured and described two years ago in the *American Entomologist*, and of the egg-destroying *Thrips* which I mentioned last year in a paper published in the Illinois State Horticultural Transactions for 1869 (p. 90), and these two parasites, the grower of our luscious stone-fruits may with good reason begin to hope for better days, for the prospect brightens. There is no philosophy in the statement of Mr. W. B. Ransom,* that we can never hope for assistance from parasites, because, as he confidently expresses it, "there are none at present but what have always existed!" Such argument will do for the believers in the old-school doctrine, that every thing was created just as we find it; but not for those who rightly comprehend the Darwinian hypothesis of development, and who believe that life is slowly undergoing change and modification to-day just as it ever has since it had an existence on this Earth. For my own part, nothing has ever appeared more absurd than the direct creation of something out of nothing, and I would as soon believe that we all dropped full grown from the clouds—instead of being brought into the world by natural means and gradually developing into manhood and womanhood—or that we have the same habits as our barbarous ancestors had; as to believe that the animal life about us is now as it was in the beginning! Therefore, though these Curculio parasites may have existed in this country long ere the white man first beheld its shores, yet they may only have acquired the habit of preying upon the Curculio within the last comparatively few years. Moreover, much benefit may be derived from their artificial propagation and dissemination, and—utopian as the scheme may appear—I intend next year, *Deo volente*, to breed enough of the first mentioned species to send at least a dozen to every county seat in the State, and have them liberated into some one's peach orchard.

THE APPLE CURCULIO.—*Anthonomus quadrigibbus*, Say.

"Prove all things; hold fast that which is good!"

This injunction of St. Paul applies with just as much force to us to-day, as it did in centuries past to the Thessalonians. In what has been said above about the Plum Curculio, we have had abundant opportunity of testing the soundness of the old proverb, and in ascertaining the history of the Apple Curculio, which I am about to give, it was very necessary to bear the advice in mind. It often takes years to undo the assertions of men who are in the habit of talking glibly of

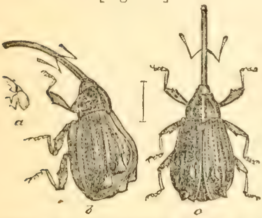
* *Prairie Farmer*, June 4th, 1870.

that which they really know nothing about, and I ought to comment severely on what has been said about this insect; but I refrain from doing so, in this case, lest it be said that my words are prompted from personal considerations.* I shall therefore content myself with a plain narrative of this insect's habits.

First then, let us explain the differences between the perfect states of this insect and the Plum Curculio, that any one may distinguish between them.

The snout of the Plum Curculio hangs down like the trunk of an elephant; it is short, stout, and does not admit of being stretched out horizontally forwards; and as may be seen by referring to the figure (Fig. 1, *c*) is scarcely as long as the head and thorax together, and can be folded back between the legs, where there is a groove to receive it. The Plum Curculio is broadest across the shoulders and narrows behind, and moreover, the black sealing-wax-like, knife-edged elevations on the back, with the pale band behind them, characterize it at once from all our other fruit boring snout-beetles.

[Fig. 10.]



The Apple, or Four-humped Curculio (Fig. 10, *a*, natural size; *b*, side view; *c*, back view,) is a smaller insect with a snout which sticks out more or less horizontally and can not be folded under, and which in the male is about half as long, and in the female is fully as long as the whole body. This insect has narrow shoulders and broadens behind, where it is furnished with four very conspicuous humps, from which it takes its name. It has neither the polished black elevations nor the pale band of the Plum Curculio. In short, it differs generically, and never attacks stone fruit.

The size varies from 1-20th to nearly 1-12th of an inch, but the colors are quite uniform, the body being ferruginous or rusty-brown often with the thorax and anterior third of the wing-covers ash-gray —the thorax having three more or less distinct pale lines.

ITS NATURAL HISTORY.

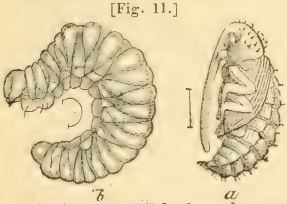
This beetle like the Plum-weevil is a native American insect, and has from time immemorial fed on, and bred in, our wild crabs. It is also commonly met with on the Thorn, and Mr. Wm. Saunders, of London, C.W., tells me that though abundant on the last named tree, it has not yet learned to attack the apple in his locality. It eventually learned to like our cultivated apples and pears, and is also found on quinces. At present it does considerable damage to the crop in some localities, though it yet prefers the wild to the cultivated fruit. Like

* My views on this subject, with comments on what has been said about this insect, may be found in a controversy, in articles published in the *American Entomologist and Botanist*, Vol. II, pp. 225–7 and 268–71; the *Prairie Farmer*, July 16th, 23d and Aug. 27th, 1870; and the *Journal of Agriculture*, Oct. 13th, and Nov. 10th and 17th, 1870.

the Plum-weevil also, it is single-brooded, and winters over in the beetle state, though I was led to believe differently a year ago. With its long thin snout it drills holes into the fruit, much resembling the puncture of a hot needle, the hole being round, with a more or less intense black annulation. and an ash-gray centre. Those holes made for food are about one-tenth of an inch deep and generally scooped out broadly at the bottom in the shape of a gourd. Those which the female makes for her eggs are scooped out still more broadly and the egg at the bottom is often found larger than the puncture at the orifice —thus indicating that it swells from absorption, by a sort of endosmosis, of nutritive fluid from the surrounding fruit, just as the eggs of many saw-flies and of some other snout-beetles are known to do.

The egg is fully 0.04 of an inch long, nearly oval, not quite three times as long as wide, and of a yellowish color, with one end dark and empty when the embryo larva is well formed. The egg-shell is so very fine that the larva seems to gradually develop from it instead of crawling out of it; and by taking a matured egg and gently rolling it between the thumb and finger, the young larva presents itself, and at this early age its two little light brown mandibles show distinctly on the head. As soon as this larva hatches it generally goes right to the heart of the fruit and it feeds there around the core, producing much rust-red excrement, and acquiring a tint of the same color. It feeds for nearly a month, and when full grown presents the appearance of Figure 11, *b*.

[Fig. 11.]



It differs so remarkably from that of the Plum Curculio that the two insects can be distinguished at a glance even in this masked form. It is softer, the chitinous covering being thinner and much whiter. It cannot stretch straight and travel fast as can that of the Plum Curculio, but curls round with an arched back, joints 4–7 being larger than the preceding. It is more crinkled, each joint being divided into three principal folds much as in the common White Grub. The space between the folds is frequently bluish-black, and there is a very distinct, continuous, vascular, dorsal line of a bluish color. It has no bristles like *nenuphar* except a few weak ones on the first joint, arising from some ventral tubercles which remind one of feet. The head is yellowish-brown with the jaws somewhat darker, and the breathing pores, except that in the fold of the first joint, are not easily seen.

IT TRANSFORMS IN THE FRUIT.

The fruit of the wild crab containing this larva never falls, and the fruit of our cultivated apples seldom; and in this respect the effect of its work differs remarkably from that of the Plum Curculio, or even of the Codling Moth. Why such is the case it would be difficult to explain! It is one of those incomprehensible facts which at every turn confront the student of Nature's works. We might with equal reason ask why it is that of the two stone fruits, the plum and the cherry, the larger falls and perishes and the smaller hangs on and lives, when infested with the Plum Curculio; and of the two pomaceous fruits, the apple and the haw, the larger likewise falls and perishes and the smaller hangs on and lives, when infested with similar larvæ? Most persons would naturally infer that the larger instead of the smaller fruits would best resist the injurious gnawings of the worm within; and though we may explain away the paradox by supposing that the longer stem of the smaller fruits prevents the injury from reaching its juncture with the branch, so readily as it does through the shorter stem of the larger fruits; or that the greater weight of the larger fruit causes it to fall so readily; yet this is only assuming, and I doubt whether the vegetable pathologist will ever be able to show the peculiarities of the fruits which cause the different effects.

The larva of the Apple Curculio has no legs and is so humpbacked that it cannot stretch out, and would cut a very sorry figure in attempting to descend the tree. Therefore, as the fruit containing it mostly hangs on the tree, the insect is effectually imprisoned. But Nature's ways are always ways of wisdom and her resources are inexhaustible! Consequently we find that instead of having to go under ground to transform, as does the Plum Curculio, the normal habit of our Apple Curculio is to transform within the fruit. The larva, after becoming full fed, settles down in a neat cavity, and soon throws off its skin and assumes the pupa state, when it appears as at Figure 11, *a*. After remaining in this state from two to three weeks it undergoes another moult and the perfect beetle state is assumed. We thus see that the Apple Curculio is cradled in the fruit in which it was born till it is a perfect beetle, fully fledged, and ready to carry out the different functions and objects of its life. In other words, it never leaves the fruit, after hatching, till it has become a perfect beetle. This fact I have fully tested by breeding a number myself both from infested crabs which I collected, and from cultivated apples, also infested, that were kindly forwarded to me by Mr. J. B. Miller, of Anna, Illinois. I learn also from Mr. George Parmelee of Old Mission, Michigan, that he has satisfied himself of the same trait in the natural history of this insect, and I fully convinced myself that such was the normal habit, by repeatedly removing the full grown larva from the fruit and placing it on the surface of the ground, when, in every instance, it would make no attempt to bury itself, but would always transform on the surface.

THE AMOUNT OF DAMAGE IT DOES.

The observations that I have been able to make on this insect's work in our cultivated orchards are limited, but I think that it attacks with equal relish both summer and winter apples. Whenever a beetle has perfected in the fruit, it cuts quite a large hole for its escape, and these holes are sufficiently characteristic to enable one who has paid attention to the matter to tell with tolerable certainty whether an apple has been infested with Apple-worm, Plum Curculio, or Apple Curculio—even after the depredator has left.

In the southern portion of Illinois and in some parts of Missouri this insect is very abundant and does much damage to the apple crop; it occurs in greater or less numbers in most States of the Union, but in other localities again its work is scarcely ever seen, and I am satisfied that the damage it does has been much overrated. We can only judge of the future by the past, and though we may expect this insect to increase somewhat with the increase of our orchards, it is folly to suppose that it can go on increasing in geometrical ratio; and the pretty mathematical calculations which are intended to alarm the cultivator at the gloomy prospects of the future, are never made by those who understand the complicated net-work in which every animal organism is entangled, or who rightly understand the numerous influences at work to keep each species within due bounds. Such figures look well on paper, but, like air-castles, there is nothing real about them.

Our apples suffer much more, in many localities, from the gougings of the perfect beetle and the burrowings of the larva of the Plum Curculio, than they do from the work of this Apple Curculio; and this was so much the case in my own locality the past summer, that I found a dozen larvæ of the former in apples, where I found one of the latter.

At the late meeting of the Illinois State Horticultural Society, Mr. E. Daggy, of Tuscola, Illinois, had on exhibition some pears that were very much deformed and gnarled. This injury had been caused by the Apple Curculio, which Mr. Daggy recognized from figures and specimens which I had with me. Upon examining the pears I found a little dark circular spot which indicated distinctly where the snout of the beetle had been inserted. This spot was the center of a hard and irregular but generally rounded knot or swelling, which was sunk in a depression of the softer parts of the pear, thus indicating that the growth, by some property of the puncture, was checked and hardened, while the other parts went on growing and swelling. Some of the fruit was so badly disfigured that it could no longer be recognized, and Mr. Daggy informed me that his Vicar of Winkfield, Bergamott and "Sugar" pears were most affected in this way, and that his Duchesse pears were unblemished.

While the fruit is growing these punctures, in almost every in stance, cause just such calloused spots and deformities as those des cribed above, but when the fruit is ripe they have a far more pernicious effect, for they generally cause the fruit to rot. It is now a well established fact that the common Plum Curculio causes the dreaded rot in peaches, plums, etc., to spread at a fearful rate by the punctures and gougings which it makes on the ripening fruit; and that where this predisposing influence is guarded against, such rot is generally confined to comparative narrow limits or does not occur at all. Many varieties of apples are disposed to rot in a similar manner, and to fall from the tree just as they are ripening. This rot in apples, as may be seen from the transactions of our State Horticultural Society, was very prevalent last fall—the Rawles Janet being especially predisposed to it—and there can be no doubt but that the punctures and gnawings of the little Turk, combined with those of the Apple Curculio are likewise the pricipal agents in producing it; for I have over and over again noticed the rot to spread in a circle from these punctures, not only on hanging fruit but just as invariably upon fruit punctured after it was plucked. Whether we believe that the fungus growths, often noticeable on such rotting fruit, are the direct result of the punctures, or that the latter only act indirectly by furnishing a proper nidus for the infectious fungus-spores which are supposed to be ever floating in the atmosphere, is a question which I shall not now stop to consider, though I have my own views which are somewhat heterodox. In either case, the Curculios are just as much to blame, and this should be an additional incentive to a general warfare upon them. Judge A. M. Brown, of Villa Ridge, has noticed that some varieties of apples are much more subject to rot and also more subject to the attacks of Curculios than others,* and it is to be hoped that he will make further observations and give us a reliable list of such varieties, and that other fruit-growers will do the same.

THE SEASON OF THE YEAR DURING WHICH IT WORKS.

The beetles come from their winter quarters and begin to work on the fruit at about the same time as does the Plum Curculio—if anything, a little later. They have generally got fully to work, and larvæ may be found already hatched by the first of June, and they may be found in the fruit, in one stage or another, all along through the months of June and July and the greater part of August.

REMEDIES AND PREVENTIVE MEASURES.

Notwithstanding we have had reports, published in the columns of our agricultural papers, of the relative number of Apple and Plum Curculios captured from peach trees by jarring with the Curculio-catcher, I am fully convinced that such reports were not based on facts, and that we may never expect to subdue this insect by the jarring process. It is not as timid or as much inclined to drop as the Plum Cur-

*Prairie Farmer, January 28, 1871.

culio, and though it can occasionally be brought down, it generally remains defiantly on the fruit or on the bough, through the gentlest as well as the severest jarring of the tree. Indeed, its habit of transforming in the fruit, places it in a great measure beyond our control, and I fear that this is one of the few insects with which we can do but little by artificial means. But we have only just commenced to understand this foe, and there is much yet to learn about it. I sincerely hope that the few facts which have been here given, will increase the reader's interest in this insect and enable him to carry on future observations and experiments with a better understanding; so that they will at last result in making us masters of this rather difficult situation. Mr. H. Lewelling, of High Hill, Montgomery county, Missouri, who has had much of his fruit injured by this insect, informs me that Tallman's Sweet is preferred by it to all other varieties, and our observations should, as much as possible, tend in the direction of deciding which varieties are most subject to, and which most exempt from its attacks; and which varieties fall most readily when infested by it. For it is obvious that with our present knowledge, the only real remedy which yet exists, is the destruction of the infested fruit, whether upon or off the tree; and it may turn out that although we cannot jar down the beetles, we can jar down much of the infested fruit, which would, without jarring, remain on the trees.

ANTHONOMUS QUADRIGIBBUS, Say—*Larva* (Fig. 11, *b*)—Average dorsal length when full grown 0.45 inch; soft and white, with a very few sparse soft hairs; arched and wrinkled Lamellicorn-fashion, the space between the wrinkles, and a distinct dorsal vascular line, bluish-black. Head free and almost perpendicular, yellowish-brown with the mandibles darker. A pair of polished ventral tubercles on each of the three thoracic joints, and each bearing a distinct bristle.

Pupa (Fig. 11, *a*)—Average length 0.40 inch. Whitish, the snout of ♀ reaching beyond tip of wing-cases, that of ♂ not much beyond the elbow of middle femora and tibiæ. Thorax with a few short stiff hairs springing from slight conical elevations. Wing-cases showing the striæ and humps of future beetle, the tip of the upper case usually terminating in a thorn. The nine abdominal joints deeply and distinctly separated, the first showing a rounded scuttellar tubercle; the sides angular, conically ridged and armed on each joint with two brown thorns or bristles, which become stouter towards apex; a transverse dorsal row of about eight similar bristles on the posterior sub-margin of each joint, also becoming larger towards apex: Terminal subsegment ending in *one* stout, slightly curved, thorn.

THE QUINCE CURCULIO—*Conotrachelus cratægi*, Walsh.

HOW IT DIFFERS FROM THE OTHERS.

This insect has been called the Quince Curculio by Dr. Trimble, and though it breeds in other fruits, the name is a good one as it will enable us to distinguish it at once from our other fruit snout-beetles. I have had the beetle in my cabinet for several years, but knew nothing of its larval history till a year ago last fall. It breeds very abundantly in our common haws, and I raised a number of them the present season from the fruit of the Pear or Black Thorn (*Cratægus tomentosa*) obtained from Mr. Walsh.

[Fig. 12.]

Though belonging to the same genus as our Plum Curculio, and having very much the same form, as may be seen by referring to the figure, (Fig. 12, *a* side view; *b* back view), yet it differs remarkably in its habits from both of the preceding weevils. It is, like them, an indigenous species, and its original fruit was evidently the wild Haw, which in the West it yet seems to prefer to the cultivated fruits. But in the East it has become very injurious to the Quince and, as we might naturally expect, also attacks the Pear, and especially the Lawrence and other late varieties. In September, 1868, I received specimens from W. W. Sweet, of Highstown, N. J., with the statement that they were found on pears, and Dr. Trimble at a late meeting of the New York Farmers' Club (Oct. 22, 1870), gave the following account of its injuries in New Jersey the present year:

"Yesterday five or six hundred were taken from the bottoms of two barrels of quinces, although those quinces had only been gathered four days before. A friend of mine has a quince orchard of 286 trees. These trees this season should average seventy or eighty quinces to a tree, making more than twenty thousand. Upon a most careful search I was unable to find one specimen perfect, or clear of one or more blemishes caused by the punctures of this insect. Frequently four, five, or six grubs will be found in a single quince. Mr. Goldsmith, the owner, keeps this orchard in first-rate order; he has faithfully kept out the borers, so fatal to the quince trees; has fertilized very freely, and the cultivation is perfect. He told me yesterday, that his crop this year is thirty barrels, which will yield him about $125. Had this insect let him alone he should have had at least 100 barrels, worth $800 to $1,000. Many of his later pears, including the Seckel and Lawrence, have suffered greatly, though not to the same extent as his quinces. A few days ago he emptied a barrel of cullings, chiefly Lawrence pears, and in and near the bottom of that barrel were found at least 400 of these grubs. A month ago I visited the orchards attached to one of the best nurseries in Pennsylvania, and I found the sad evidence of the presence of this enemy. Even the Seckel pears, though very abundant, were almost worthless; later varieties still worse. Mr. Fuller tells me that he has seen this season, in Western New York, the same condition of fruit at a well known nursery, even the Duchesse pears almost totally destroyed. This fruit enemy seems yet confined to localities; but is spreading rapidly."

This beetle was first very briefly described by Mr. Walsh in a note in the *Prarie Farmer* for July 18th, 1863, p. 37, from specimens found by him on the hawthorn, but until I bred it this spring, nothing was known of its larval history. It is a somewhat larger insect than the Plum Curculio, has a comparatively longer snout, and is very broad-shouldered; thus tapering just the opposite way to the Apple Curculio. Its general color is a tolerably uniform ash-gray, mottled more or less with ochre-yellow, dusky and whitish, and it has a dusky somewhat triangular spot at the base of the thorax above, and seven distinct narrow longitudinal elevations on the wing-covers, with two rows of punctures between each.

This beetle differs further from the others, in the fact that it does not appear, even in the latitude of St. Louis, till about the first of June, and I have had its larvæ of the previous year in the ground in May, when the newly hatched larvæ of the Plum Curculio were already working destruction in the fruit. In some of the more northern States it would not appear till the middle of July.

ITS TRANSFORMATIONS AND HABITS.

This snout-beetle does not make a crescent like the Plum Curculio; but, like the Apple Curculio, makes a direct puncture for the reception of its egg, the hole being somewhat larger than that of the latter, and the bottom of the cavity similarly enlarged and gnawed, so as to form a neat bed for the egg. The egg is very similar to that of the Plum Curculio, and hatches in a few days after being deposited. In all probability it also swells and enlarges somewhat before hatching. The larva works for the most part near the surface of the fruit, and does not enter to the heart. It is of the general form of that of the Plum Curculio, and differs principally in being somewhat larger, more opaque-white, and in having a narrow dusky dorsal line and a distinct lateral tubercle on each joint. When full grown, which is in a month or more from the time of hatching, it leaves the fruit through a smooth cylindrical hole and burrows two or three inches into the ground. Here, singularly enough, it remains all through the fall, winter and spring months without changing—no matter whether it left the fruit as early as the first of August or as late as the first of October. This is the peculiar feature of the insect, namely, that it invariably passes the winter in the larva state, and does not even assume the pupa state till the fore part of May, or a few days before issuing as a beetle. In this respect it resembles the nut-weevils which infest our hickory-nuts, hazel-nuts and acorns. In higher latitudes than that of St. Louis, there is evidence that some of the late hatched larvæ do not leave the haws they infest till frost overtakes them, but pass the winter within the fruit as it lies on the frozen ground. The pupa differs only from that of the Plum Curculio in the greater length of the proboscis.

I have already referred to the fact that Dr. Fitch supposed the Plum Curculio to be two-brooded, and those who have read his "Address" on this insect will readily perceive that he based his opinion on finding what he took to be its larvæ in the tender bark of a pear twig late in the fall, and on finding what he similarly mistook for such larvæ in haws in winter. Of course, we know positively now that the Plum Curculio does not so breed in pear twigs, and it is very evident that what Dr. Fitch took to be Plum Curculio larvæ in such a twig, were the young of some other insect, or perhaps even the eggs of some leaf-hopper (*Tettigonia*), which are generally placed in the position described by him. But, though this first error of Dr. Fitch's has been explained away, the second never has till now, when we may assume, with great reason, that the larvæ which misled the Doctor, and which were found in haws in winter time, were in reality the larvæ of our Quince Curculio. How easily are fallacies exploded, and errors corrected, even years after they are committed, by a few well tested facts!

The two former Curculios which we have been considering have a beetle existence of between nine and ten months, during most of which time, or as long as the weather is sufficiently mild, they feed in the manner described. The present species has a beetle existence of not more than two months, and as though aware of the short term allotted to it for enjoyment, it endeavors to make the best use of its time. Consequently we find it more ravenous than either of the other species, and it is really astonishing how much this insect eats. It excavates immense holes for food, often burying itself in them completely, and I have known apples furnished to these beetles in confinement, to have their substances so completely devoured that nothing but the rind was left. Two years ago last fall there was scarcely a quince that came into the St. Louis market that was not marred by numbers of large gougings, and though I was then inclined to attribute such holes to the gnawings of grasshoppers, I feel pretty well convinced at present that the work might with more justice have been attributed to this Quince Curculio.

The question will naturally arise, since this insect breeds in the Haw, the Quince and the Pear, whether it will also breed in the closely allied Apple? So far as my experiments go, they indicate clearly that it will not; for although the beetle will eat and greatly disfigure apples, when no other nourishment is at hand, yet a number which I confined to a large branch of an apple tree on the 14th of June last, absolutely refused to deposit eggs, and died three weeks afterwards.

REMEDIES.

Very fortunately this insect drops as readily when alarmed as does the Plum Curculio, and the jarring process will be found just as effectual in catching it, with the additional advantage that the jarring need only be carried on for about ten weeks of the year, namely, from about the first of June to the middle of August in this latitude. Moreover, in accordance with its late appearance, we find that, according to Dr. Trimble, whenever it attacks pears, it prefers the late ripening varieties. Again, it is, like the Plum Curculio, nocturnal in its habits, and secretive during the day, so that the Ransom process will undoubtedly prove effectual with it, if used at the right season. All fruit that falls should be destroyed, and as we know that the larva hibernates in the ground, many of them will be injured and destroyed by late stirring of the soil.

CONOTRACHELUS CRATÆGI, Walsh—*Larva*—Average length when full grown 0.32 inch; 4½ times as long as wide, and straight. Opaque whitish, with a narrow dusky dorsal line, generally obsolete on thorax, and a few very short hairs. Distinct lateral tubercles on all the joints. Head rufous with mandibles black, except at base, and distinctly two-toothed at tip.

Pupa—Average length 0.28 inch. Snout reaching a little beyond elbow of middle tibiæ and tarsi, with two stout rufous thorns near the origin of antennæ, two more at base and sometimes others more toward the tip. Head and thorax also armed with such thorns, and also two to each elbow of the femora and tibiæ. Wing cases with rows of short rufous bristles along the elevations between the striæ. Abdomen cylindrical, the basal joint with a central scutellar bristleless tubercle and two others, one each side of it, each bearing a bristle; the other joints conically tubercled, laterally, each tubercle bearing a stout bristle, and each joint bearing dorsally about four other bristles on its posterior sub-margin. Terminal sub-segment squarely cut off and bearing *two* stout inwardly-curved brown thorns.

THE PLUM GOUGER.—*Anthonomus prunicida*, Walsh.

ITS CHARACTER, DISTRIBUTION, AND FOOD.

This name was given by Mr. Walsh to another indigenous weevil which is represented enlarged in the accompanying illustration (Fig. 13).

[Fig. 13.]

It is easily distinguished from either of the preceding weevils, by its ochre-yellow thorax and legs, and its darker wing-covers, which are dun-colored, or brown with a leaden-gray tint, and have no humps at all. Its snout is not much longer than the thorax, but as in the Apple Curculio, projects forwards, or downwards but cannot be bent under as in the Plum Curculio. This insect was first described in the *Prairie Farmer* for June 13th, 1863, and the description was afterwards republished in the Proceedings of the Boston Society of Natural History for February, 1864.

Mr. Walsh gave such a good account of it in his report as Acting State Entomologist of Illinois, that it is unnecessary for me to go into detail, and I will therefore only briefly allude to those traits in its history which are well established.

The Plum Gouger seems to be unknown in the Eastern States, or at least is not common there; but it is very generally distributed throughout the Valley of the Mississippi. As a rule it is much less common and does much less injury than the little Turk, though in some few districts it is found equally abundant, and I received specimens on the first of June last, from my esteemed correspondent Mr.

Huron Burt, of Williamsburg, Callaway county, Mo., with the statement that it was doing great damage to the plums in that locality, though the little Turk was scarcely met with. There is a plum known there as "Missouri Nonsuch" which, though said to be Curculio proof, is worked upon very badly by the Gouger.

The Plum Gouger is often found on wild crab trees, and may, like the Plum Curculio, occasionally deposit and breed in pip fruit; but it is partial to smooth-skinned stone-fruit such as prunes, plums, and nectarines, and it does not even seem to relish the rough skinned peach.

OFTEN MISTAKEN FOR THE PLUM CURCULIO.

It has often been confounded with the Plum Curculio, and was once supposed by my friend L. C. Francis, of Springfield, Ills., to be the male of that species. We all have a right to suppose what we please, and as long as our suppositions are not thrust on the public for ascertained facts, they can do no possible harm. But Mr. J. P. Williamson, of Des Moines county, Iowa, is not satisfied with supposing this or some other straight-snouted weevil, to be the female of the Plum Curculio, but, in a last summer's issue of the *Prairie Farmer*, not only emphatically speaks of it as such, but, finding that these supposed females frequent the trees two weeks earlier than the males, (?) he concludes for some unexplained reason, that the sole object of visiting the fruit is for the deposition of eggs; and straightway hatches the theory that the Plum Curculio can do no harm till the males appear! Consequently, instead of jarring our trees as long as fruit remains on them, we are informed by Mr. Williamson that it is only necessary to jar them about six weeks.

And thus it always is with men who do not sufficiently understand the absolute importance of care and caution in reading Nature's secrets: from supposition to assumption; from assumption to theory; from theory to advice, which—it is unnecessary here to say—is of a most pernicious character.

ITS TIME OF APPEARANCE.

This beetle appears in the spring about the same time as the Plum Curculio, but as no eggs are deposited after the stone of the fruit becomes hard, and as its larva requires a longer period to mature than that of the latter, its time of depositing is shorter, and the old beetles generally die off and disappear before the new ones eat their way out of the fruit, which they do during August, September, and October, according to the latitude.

ITS NATURAL HISTORY.

Though we have no absolute proof of the fact, analogy would lead us to believe, and in my own mind there is no doubt, that this insect passes the winter in the beetle state, and that it is, like the other species, single-brooded. Both sexes bore cylindrical holes in the fruit for food, and these holes are of the exact diameter of the snout, and consequently somewhat larger than those of the Apple Curculio. These holes are broadened at the bottom, or gouged out in the shape of a gourd; and especially is this the case with those intended by the female for the reception of an egg. The egg, in this case also, enlarges from endosmosis, and it is probable that all weevils that make a puncture for the reception of their eggs, gnaw and enlarge the bottom, not only to give the egg room to swell, but to deaden the surrounding fruit, and prevent its crushing such egg—the same object being attained by the deadened flap made by the crescent of the little Turk. Wherever this insect abounds, plums will be found covered with its holes, the great majority of them, however, made for feeding purposes. The gum exudes from each puncture, and the fruit either drops or becomes knotty and worthless.

The young larva which hatches from the egg, instead of rioting in the flesh of the plum, or remaining around the outside of the kernel, makes an almost straight course for that kernel, through the yet soft shell of which it penetrates. Here it remains until it has become full-fed, when by a wise instinct it cuts a round hole through the now hard stone, and retires inside again to change to the pupa and finally to the beetle state. When once the several parts of the beetle are sufficiently hard and strong, it ventures through the hole which it had already providently prepared for exit with its stronger larval jaws, and then easily bores its way through the flesh and escapes.

It must not be forgotten that, while the kernel of the fruit is yet soft, the larva of the little Turk often penetrates and devours it; but in this case the soft stone is more or less reduced to reddish powder, whereas the larva of the Plum Gouger enters the stone and feeds on the inside while the outside hardens. The normal habit of the former is to feed on the outside; that of the latter on the inside of the stone.

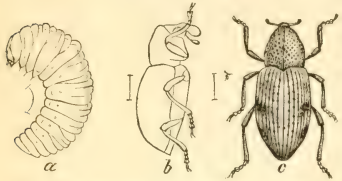
REMEDIES.

This Plum Gouger is about as hard to deal with as the Apple Curculio. It drops almost as reluctantly and we therefore cannot do much by the jarring process to diminish its numbers. Moreover it takes wing much more readily than the other weevils we have mentioned; and though fruit that is badly punctured for food, often falls prematurely to the ground, yet, according to Mr. Walsh, that infested with the larva generally hangs on the tree until the stone is hard and premature ripening sets in. In all probability the stunted and prematurely ripened fruit containing this insect will jar down much more readily than the healthy fruit, but I have so far had no opportunity of making any practical observations myself, and must conclude by hoping that our plum-growing members will make the proper experiments and give us the results.

THE STRAWBERRY CROWN-BORER.—*Analcis fragariæ* N. sp.

This is another indigenous insect, which seems to be confined to our Mississippi Valley, for I have heard no complaints in any of the Atlantic States, of injuries that could be attributed to this weevil. In the *Maine Farmer* for July 25th, 1867, we find a brief reference, made by Mr. G. E. Brackett of Belfast, Me., in answer to a certain "E. B.," of a "worm that eats into the crown of the plant and kills it." The worm referred to was, in all probability, the Crown-borer under consideration, but as no postoffice address of the questioner is given, the paragraph might just as well never have been written, for any light that it throws on the distribution of the insect. However, no such insect has ever been mentioned by our Eastern writers on the Strawberry, and we must necessarily conclude that it does not exist in the Atlantic States.

[Fig. 14.]



This insect has done considerable damage to the strawberry crop in the southern portion of Illinois, especially along the line of the Illinois Central Railroad; and I have seen evidence of its work in St. Louis county, Mo. At the meeting of the Southern Illinois Fruit Growers' Association, held at South Pass, in November, 1867, several complaints were made by parties from Anna and Makanda, of a white worm which worked in the roots of their strawberries and in 1868, the greater portion of the plants of a ten-acre field at Anna, belonging to Mr. Parker Earle, was destroyed by it.

In the fall of 1869 I had some correspondence with Mr. Walsh on this insect, and learned that he had succeeded in breeding it to the perfect state; and had it not been for his untimely death, its history would no doubt have been published a year ago. Through the kindness of Jos. M. Wilson, of Sterling, Whiteside county, and of J. B. Miller, of Anna, Union county, Ills., I received during the past year specimens of the larvæ, from which I succeeded in rearing the perfect beetle. It is therefore by the aid of these gentlemen, and especially from the experience of Mr. Miller, that I am enabled to give the above illustrations (Fig. 14) of the Strawberry Crown-borer, and the following necessarily imperfect account of its mode of working. I give them in the hope that they will prompt further investigation, and serve as a clue to enable others who have opportunity, to increase our knowledge of this pest; for there is much yet to learn of its habits, and consequently of the best means of fighting it.

From the middle of June to the middle of July in Southern Illinois, and later further north, the larva hatches from an egg which, in all probability, is deposited in the crown of the plant, and it immediately commences to bore its way downwards, into the pith. Here it remains till it has acquired its full size, working in the thick bulbous root and often eating through the more woody portions; so that when frost sets in, the plant easily breaks off and is heaved out of the ground. When full grown it presents the appearance of Figure 14, *a*, being a white grub with arched back and tawny-yellow head, and measuring about one-fifth of an inch when stretched out. It undergoes its transformations to the pupa and perfect beetle states within the root, and the latter makes its appearance above ground during the month of August.

The beetle (Fig. 14, *b* side view; *c* back view) is about 1-6th of an inch in length, of a chestnut-brown color, and marked and punctured as in the figure.

From analogy we may infer that the beetle feeds on the leaves of the strawberry, for it is a very general rule with snout-beetles, that the perfect insects feed on the leaves of such plants as they infest in the larva state. But whether it lives on through the winter as a beetle and does not commence depositing eggs again till the following June; or whether it is double-brooded and produces a second lot of larvæ which pass the winter in the roots, are questions which are not yet decided; and until we get a more comprehensive knowledge of this insect's ways and doings, we shall be in a measure powerless before it. From all the facts that can be obtained, the first hypothesis is the correct one, and in that event we can, in an emergency, easily get rid of this pest by plowing up and destroying the plants soon after they have done bearing, or say about the latter part of June in the latitude of St. Louis. By doing this the whole brood of borers will perish with the plants. Most strawberry-growers renew their plants, in some way or another, about every three years, and where this insect abounds, it will be best subdued by destroying the whole bed at the time already suggested and afterwards planting a new one; rather than by annually thinning out the old and leaving the new plants in the same bed. Here we have an effectual means of extirpating the little pest, if, as I believe, the first hypothesis is the correct one; but if the second hypothesis be correct—i. e., if the insect be double-brooded—then it will avail nothing to carry out the above suggestions, and we thus see how important it is to thoroughly understand an insect's habits in order to properly cope with it. Though we may occasionally hit upon some plan of remedying or of preventing an insect's injuries without knowing its habits, yet as a general rule we but grope in the dark until we have learned its natural history!

According to Mr. Miller, all plants infested with this larva are sure to perish, and he has also noticed that old beds are more apt to be injured by it than new ones.

In one of the roots received from him, I found a parasitic cocoon, so that there is every reason to believe that, as is so very generally the case with insects, this noxious species has at least one natural enemy which will aid us in keeping it in due bounds. Indeed, Mr. Miller so often found this parasitic cocoon, that he at first surmised that the Crown-borer spun it. But no snout-beetle larvæ spin cocoons.

This Crown-borer must not be confounded with another white worm of about the same size which lives in the ground and subsists on the roots by devouring them from the outside. This last may always be distinguished by having six distinct legs near the head, and its habits are quite different. It occurs earlier in the season, and, as I have proved the past summer, is the larva of the little clay-yellow beetle, known as the Grape-vine Colaspis (*Colaspis flavida*, Say). A full account of this last insect, with illustrations, will be given in a later portion of this Report.

The Crown-borer belongs to the genus *Analcis* which is distinguished by its sub-cylindrical oblong-oval body, its short robust snout which fits into a deep grove, its 10-jointed antennæ, and its simple or unarmed thighs. As it is a new species I subjoin a description of it for the scientific reader :—

ANALCIS FRAGARIÆ, N. Sp.—*Imago*, (Fig 14, *b*, *c*)—Color deep chestnut-brown, sub-polished, the elytra somewhat lighter. Head and rostrum dark, finely and densely punctate and with short coarse fulvous hairs, longest at tip of rostrum; antennæ rather lighter towards base, 10-jointed, the scape much thickened at apex, join 2 longest and robust, 3 moderately long, 4–7 short, 8–10 connate and forming a stout club. Thorax dark, cylindrical, slightly swollen across the middle and uniformly covered with large thimble-like punctures, and with a few short coarse fulvous hairs, unusually arranged in three more or less distinct longitudinal lines; pectoral groove ending between front legs. Abdomen with small remote punctures and hairs which are denser towards apex. Legs of equal stoutness, and with shallow dilated punctures and uniform very short hairs Elytra more yellowish-brown, dilated at the lower sides anteriorly, and with about 9 deeply-punctured striæ, the striæ themselves sometimes obsolete; more or less covered with coarse and short pale yellow hairs which form by their greater density, three more or less conspicuous transverse bands, the first of which is at base; between the second and third band, in the middle of the elytron, is a smooth dark-brown or black spot, with a less distinct spot of the same color below the third, and a still less distinct one above the second band. Length 0.16 inch.

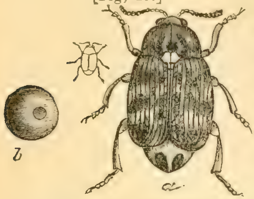
Described from four specimens bred from strawberry-boring larvæ. The black spots on the elytra are quite distinct and conspicuous on two specimens, less so on one, and entirely obsolete on the other.

Larva, (Fig. 14 *a*)—White with back arched Lamellicorn-fashion. Head gamboge-yellow, glabrous, with some faint transverse striations above mouth; mandibles rufous tipped with black; labrum emarginate, and with palpi, pale. A faint narrow dorsal vascular line. Legs replaced by fleshy tubercles. Length 0.20 inch when stretched out.

THE PEA-WEEVIL—*Bruchus pisi*, Linn.

Our common garden pea has not many insect enemies, for with the exception of the Striped Flea-beetle (*Haltica striolata*), which gnaws numerous small holes in the leaves, and the Corn-worm *alias* Boll-worm (*Heliothis armigera*), which eats into the pod, there are very few others besides the Pea-weevil under consideration. This species alone is so numerous, however, as to be a serious drawback to pea culture in this part of the country.

[Fig. 15.]



b

The term *Bruchus*, meaning a devourer, was given by the celebrated Linnæus to a genus of beetles which at first appear to have very little resemblance to the Snout-beetles. They form, however, at present, a sub-family (*Bruchides*) of the great Snout-beetle family, though they posses nearly as close affinities to the great *Chrysomela* family, and really form a connecting-link between the two. They are characterized by a depressed head and very short snout, by the antennæ being 11-jointed, straight and but slightly thickened towards the end, by the wing-covers being shorter than the abdomen, and by the rather long hind legs and much swollen thighs. Their larvæ are short, arched, and swollen in the middle, with a comparatively small head; and their depredations are confined all over the world, to leguminous or pod-bearing plants—another beautiful illustration of the "Unity of Habits" referred to on page 9.

They are far more abundant in the tropics than in more temperate climes, and in North America we have not many species to contend with. With the exception of the Honey-locust seed-weevil (*Spermophagus robiniæ*, Fabr.), which I have bred from the seeds of that tree, there are only two species, namely: the Pea and the Bean weevils that are really injurious in our State, though *Bruchus discoideus*, Say, often badly infests the seeds of *Ipomea*. A third species, however, namely, the Grain Bruchus of Europe, has lately been introduced into this country, and may some day become unduly multiplied in our midst.

The Pea-weevil is very generally dubbed "Pea-bug," but this latter term is not nearly so appropriate as the former, to which it should give way. Though everybody may notknow by sight the perfect beetle, yet every one has most assuredly seen the work of the worm, and though knowledge of the fact may not add to our enjoyment of a mess of green peas, yet the fact nevertheless remains, that those of us in the Mississippi Valley who indulge in this delicious esculent, necessarily devour a young worm with nearly every pea that we eat. Gray's oft quoted lines,

> —"Where ignorance is bliss,
> 'Tis folly to be wise,"

Would seem to apply here with great force; but when we reflect that the diminutive and almost imperceptible worm, nourished so to speak in the very marrow of the pea, really has no flavor and produces no injurious effects on the human system; we can chuckle in our sleeves and console ourselves with the thought that, notwithstanding the above truism, "wisdom is justified of her children." Neither this nor any other of the true weevils mentioned in this paper, can do harm when taken as food in the larva state, but there is good testimony that the hard-shell beetles are injurious when fed in a ground or unground condition, along with the seeds they infest, either to man or to other animals.

The Pea-weevil which is here well illustrated, Figure 15, *a* showing a back view, and 17, *b* a side view, the small outlines at the sides showing the natural size, is easily distinguished from all other species of the genus with which we are troubled, by its larger size, and by having on the tip of the abdomen projecting from the wing-covers, two dark oval spots which cause the remaining white portion to look something like the letter T. It is about 0.18—0.20 inch long, and its general color is rusty-black, with more or less white on the wing-covers, and a distinct white spot on the hinder part of the thorax near the scutel. There is a notch on each lateral edge of the thorax, and a spine on the under side of the hind thighs near the apex. The four basal joints of the antennæ and the front and middle shanks and feet are more or less tawny. It is supposed to be an indigenous N. A. insect, and was first noticed many years ago around Philadelphia, from whence it has spread over most of the States where the pea is cultivated. This supposition is probably the correct one though we have no means at present of proving it to be so, and certain it is that, as the cultivated pea was introduced into this country, our Pea-weevil must have originally fed on some other indigenous plant of the Pulse family. It is at present found in the more southern parts of Europe and in England, and is one of the few injurious insects which have found their way there from this country; but in accordance with the facts given in my last Report, under the head of "Imported Insects and Native American Insects," which clearly prove that our native plants and insects do not become naturalized in the Old World with anything like the facility with which those of the Old World are every day being naturalized here, this Pea-weevil does not begin to be as destructive there as it is at home.

THE FEMALE DEPOSITS HER EGGS ON THE OUTSIDE OF THE POD.

It is a very general remark that peas are "stung by the bug," and the impression prevails almost universally, not only among gardeners but with many entomologists, that the female weevil punctures and deposits her eggs *in* the pea in which the larva is to be nourished. It is a little singular that so many writers should have fallen into this error, for it is not only the accepted view amongst writers for the agricultural press, but has been adopted by many eminent entomologists, Taschenberg, Harris, and Dr. Boisduval being about the only authors who have rightly comprehended the true manner of egg-depositing. All this comes of course from one man's palming off the opinions of another as his own, and by his adopting such opinions, whether good or bad, without due credit. Even Noerdlinger in his "Kleinen Feunde der Landwirtschaft," though he cites the excellent and original observations of Taschenberg, feels himself called upon to doubt their correctness, and himself inclines to believe that the female may put her eggs in the pea. In Packard's Guide, the eggs are erroneously said to be laid on the blossoms.

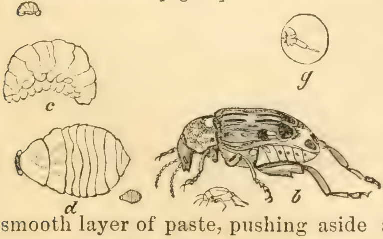
The true natural history of the Pea-weevil may be thus briefly told. The beetles begin to appear as soon as our peas are in bloom, and when the young pods form, the female beetles gather upon them and deposit their eggs on any part whatever of the surface without attempting to insert the eggs within the pod.

The eggs, (Fig. 16,) are deep yellow, 0.035 inch long, three times as long as wide, fusiform, pointed in front, blunt behind, but larger anteriorly than posteriorly. They are fastened to the pod by some viscid fluid which dries white and glistens like silk. As the operation of depositing is only occasionally noticed during cloudy weather, we may safely assume that it takes place for the most part by night. If pea vines are carefully examined in this latitude any time during the month of June, the pods will often be found to have from one to fifteen or twenty such eggs upon them, and the black head of the future larva may frequently be noticed through the delicate shell.

[Fig. 16.]

As already stated, the eggs are deposited on all parts of the pod, and the mother beetle displays no particular sagacity in the number which she consigns to each, for I have often counted twice as many eggs as there were young peas, and the larvæ from some of these eggs would of course have to perish, as only one can be fully developed in each pea. The newly hatched larva is of a deep yellow color with a black head, and it makes a direct cut through the pod into the nearest pea, the hole soon filling up in the pod, and leaving but a mere speck, not so large as a pin-hole, in the pea. The larva feeds and grows apace and generally avoids the germ of the future sprout, perhaps because it is distasteful, so that most of the buggy peas will germinate as readily as those that have been untouched. When full grown this larva presents the appearance of Figure 17, *c*, (after Curtis) and with wonderful precognition of its future wants, eats a circular hole on one side of the pea, and leaves only the thin hull as a covering. It then retires and lines its cell with a thin and smooth layer of paste, pushing aside and entirely excluding all excrement, and in this cell it assumes the pupa state (Fig. 17, *d*, after Curtis,) and eventually becomes a beetle, which, when ready to issue,

[Fig. 17.]



has only to eat its way through the thin piece of the hull which the larva had left covering the hole. It has been proved that the beetle would die if it had not during its larval life prepared this passage way, for Ernest Menault asserts* that the beetle dies when the hole is pasted over with a piece of paper even thinner than the hull itself.

REMEDIES AND PREVENTIVES.

Sometimes, and especially when the summer has been hot and prolonged, many of the beetles will issue from the peas in the fall of the same year that they were born, but as a more general rule they remain in the peas during the winter and do not issue till new vines are growing. Thus many yet remain in the seed peas until they are planted and especially is this apt to be the case with such as are planted early. We see, therefore, how easily this insect may be introduced into districts previously free from it by the careless planting of buggy peas, for it has been demonstrated that the beetle issues as readily from peas planted in the earth as it does from those stored away in the bin. All peas intended for seed should be examined and it can very soon be determined whether or not they are infested. The thin covering over the hole of the peas that contain weevils, and which may be called the eye-spot, is generally somewhat discolored, and by this eye-spot those peas which ought not to be planted can soon be distinguished. Where this covering is off and the pea presents the appearance of Figure 15, *b*, there is little danger, for in that case the weevil has either left, or, if still within the pea, is usually dead. It would of course be tedious to carefully examine a large lot of peas, one by one, in order to separate those that are buggy, and the most expeditious way of separating the sound from the unsound, is to throw them into water, when the sound ones will mostly sink and the unsound swim.

There are, however, other and more certain means of preventing the injuries of this insect, and whenever agriculture shall have progressed to that point where by proper and thorough organization all the farmers of a county or of a district can, by vote, mutually agree to carry out a measure with determination and in unison, then this insect can soon be exterminated; for it is easy to perceive that such a result would be accomplished by combinedly ceasing to cultivate any peas at all for one single year! Until some such united action can be brought about, we shall never become entirely exempt from this insect's depredations, for no matter how sound the peas may be that I plant, my vines are sure to be more or less visited by the beetles as long as I have slovenly neighbors. Yet comparatively, my peas will always be enough better to well pay for the trouble, even under these circumstances.

Insectes Nuisibles a l'Agriculture.

As already hinted the Pea-weevil prefers a warm to a cold climate, and its devastations are scarcely known in high latitudes. On this account the impression prevails that it does not occur in certain parts of Canada, and few persons are aware that it is nearly as bad, especially in Ontario, as it is with us. We are in the habit of sending to Canada for our seed peas, because we get them free from bugs; but the reason that their seedsmen have such a reputation is to be traced to their greater care in destroying the weevil and in sorting their seed rather than to any immunity from its ravages which their peas possess The following extract from a letter from Mr. Wm. Saunders, of London, Ontario, who, as secretary of the Ontario Fruit Growers' Association and as a prominent member of the Canadian Entomological Society, is as well posted, perhaps, as any one in the Dominion, will give some idea of its occurrence there:

The Pea-weevil I find prevails in all parts of Canada to a greater or lesser extent, from the Red River settlement to Quebec. In some places it is so numerous as to discourage farmers from attempting to grow peas at all, while other localities are but little troubled. About the neighborhood of Windsor (opposite Detroit) there are no peas grown worth speaking of; but 60 or 70 miles further east, towards London, they are an important crop, and about London, say within 30 or 40 miles, and as far east as Guelph and Hamilton, will include the chief district from which your western supplies are drawn.

During 1869 I grew a field of peas on my own farm. They produced a good crop, and although we have some of them on hand yet I have never observed a buggy one amongst them, although I have examined them several times. But it is rare to find them so free as that and something depends on the season. Last season the weather was very wet and the crop very light, and the dealers tell me now that there are scarcely any peas fit to ship in the country on account of the quantity of bugs they contain. They say that they always have to select for shipping, and while sending them as clean as possible they do not profess to send them entirely free from bugs.

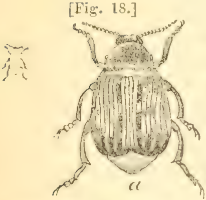
Our farmers here are perhaps a little more particular than yours about their seed. They will sometimes keep it over till the second year or else scald it before planting so as to destroy a large proportion of the bugs. The general opinion seems to be that if peas are sown late, say about the first of June, they will be almost free from bugs in any season, and some adopt this method, but it is not by any means a general thing, for should the weather set in very hot, as it sometimes does about that time, they would become somewhat dwarfed and the crop lessened. I have not heard of any one growing two crops in one season.

Many eminent seedsmen—Mr. Langdon for instance as I have been credibly informed—effectually kill the weevils by enclosing the peas in tight vessels along with camphor. The same object is attained by keeping peas two years, and taking care that the beetles do not escape before they die. Peas will grow well when kept for two years or even longer, but they should always be well dried so as not to mould. A good plan is to tie them up in bags and hang them in an airy place from the time they are gathered till about Christmas, and then in order that they may not become too dry, to put them into tighter vessels. To a certain extent sound peas may be obtained by planting late, for the period of egg-depositing is limited to about a month. Peas, as Mr. F. A. Nitchy of Jefferson City has demonstrated, may be planted in the central part of the State as late as the first of June, and by the time the plants from such late planted seed begin to bear pods, all the weevils will have died and disappeared. Wherever a second crop of peas can be grown the same year, this second crop will be entirely free from weevils, and though there seems to be some difficulty in producing a second crop in our State, on account of mildew, it is often done in higher latitudes. Choice lots of seed, if found to be infested when received from the seedsman, may be thrown into hot water for a minute or two, and the sprouting of the peas will be quickened, and most of the weevils, but not all, be killed. But whatever plan be adopted to obtain sound seed, it should be every man's aim, in duty to himself and to his neighbors, to plant none but bugless peas!

As natural checks, the Crow Black-bird is said to devour great numbers of the beetles in the spring, and according to Harris the Baltimore Oriole splits open the pods to get at the grubs contained in them.

THE GRAIN BRUCHUS—*Bruchus granarius*, Linn.

[Fig. 18.]



There is a weevil in Europe which is very common, attacking peas there as badly as our own Pea-weevil does in this country. It also infests beans and several other grains and seeds. It has on several occasions been imported with foreign seeds into this country, but very fortunately does not seem so far to have obtained a strong foothold. There is nothing to prevent its doing so, however, except the utmost vigilance on the part of those who import seeds, and it may at any time get scattered over the country by the distribution of infested seed from the Department of Agriculture, unless the authorities are ever watchful to prevent such a catastrophe. To enable a ready recognition of this weevil, I present an enlarged portrait of it at Figure 18. As will be noticed by that figure it bears a tolerably close resemblance to our own Pea-weevil, but it may always be distinguished from the latter species by the following characters as given by Curtis:—

It is in the first place a smaller insect, averaging but 0.14 inch while *pisi* averages nearly 0.20 inch. It is rather darker, there are two small white spots on the disk of the thorax, and the tooth at each side of the thorax is indistinct; the suture of the wing-covers forms a brown stripe, and the apical joint of the abdomen which protrudes beyond the wing-covers and which is otherwise known as the pygidium, is densely clothed with grayish pubescence, and shows in certain lights four minute dark dots, but no indication of the two large oval spots so characteristic of our Pea-weevil. The four basal joints of the antennæ and the front legs are reddish, and the inner spine of the hind shanks is prolonged.

It would be a sad misfortune to have this insect added to our list of injurious species, and it is no wonder that upon discovering specimens of our own Pea-weevil just disclosed in a parcel of peas which he had taken with him from America, the Swedish traveler Kalm was thrown into such a trepidation lest he should be the instrument of introducing so fatal an evil into his beloved country.

To give some idea of the habits of the Grain Bruchus, I quote the following account from Curtis's Farm Insects:—

"This species, which is everywhere abundant as early as February on the furze when it is in blossom, inhabiting also the flowers of various other plants in the beetle state, as the Rhubarb, Meadow-sweet (*Spiræa ulmaria*), etc., is a most destructive insect in our pea and bean fields, the larvæ feeding in the seeds and sometimes destroying more than half the crop. They are exceedingly abundant in some parts of Kent, where they often swarm at the end of May, and are occasionally found as late as August; indeed I killed one in November, imported with Russian beans, which had been alive since the end of September. It attempted to fly away in October; it then became torpid, but on warming it by a fire in the middle of November, it was as lively and active as in the height of summer, and I dare say would have lived through the winter.

"It is said that the female beetles select the finest peas to deposit their eggs in, and sometimes they infest crops to such an extent that they are eaten up by them, little more than the husk being left. The various kinds of beans are equally subject to their inroads; besides the long-pods I have alluded to, I have had broad Windsor beans sent to me containing these *Bruchi;* and Mr. C. Parsons transmitted me some horse-beans in the beginning of August, 1842, which were entirely destroyed by them. Mr. F. J. Graham showed me some seed beans which were inoculated by these beetles to a great extent, and some of them were alive in the seeds; yet to any one ignorant of the economy of this pest, there would not appear the slightest external indication of their operations. I also received from a gentleman residing in Norfolk a sample of seed beans from Russia, for winter sowing, a large proportion of which was perforated by this *Bruchus*.

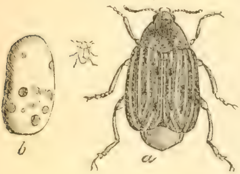
"It has already been intimated that as the beetles generally leave the germ uninjured, the vitality of infested seeds is not destroyed. I doubt, however, if they produce strong healthy plants; and from my own experience I have no doubt if peas and beans be sown containing the *Bruchus granarius*, that the beetles will hatch in the ground, and thus the cultivator will entail upon himself a succession of diseased pea and bean crops. Now to avoid this loss, the seed should be examined before sowing, when to an experienced eye the presence of these beetles will be discernible, where to a common observer they would appear sound and good. The maggots, when arrived at their full size, gnaw a circular hole to the husk or skin of the seed, whether pea or bean, and even cut around the inner surface which covers the aperture, so that a slight pressure from within will force this lid off;

these spots are of a different color to the rest of the seed, generally having a less opaque appearance, and often are of a duller tint; on picking off this little lid, a cavity will be found beneath containing either a maggot, pupa, or beetle."

THE AMERICAN BEAN-WEEVIL—*Bruchus fabæ*, N. sp.

This is another *Bruchus* which bids fair to out-do the celebrated Pea-weevil in its injurious work, and since it has but just made its appearance in our State as a bean destroyer, and is yet confined, so far as I am aware, to one single locality, I hope that the following account of it will have the effect to prevent its introduction into neighborhoods where it is now unknown, and thus keep it from spreading over the State. It appears to be a native American insect and doubtless fed originally on some kind of wild bean (*Phaseolus* or *Lathyrus*,) but it was first noticed in our cultivated beans about ten years ago, in Rhode Island, and has since at different times suddenly made its appearance in several other parts of the country. Maj. J. R. Muhleman, of Woodburn, Ills., informs me that while in South Carolina in 1863, some kind of weevil was often so common in the beans used by the army that before using such beans the men had to soak them, and afterwards lay them out to dry, in order to allow the beetles to escape. The weevil was doubtless the species under consideration, but there is no means of ascertaining from which part of the country the beans came.

[Fig. 19.]



Though already pretty well distributed in some of the Eastern States, especially in New York, it appears to be yet confined to certain localities in the Mississippi Valley. It has for instance, been quite troublesome of late years in Madison county, Ills., for I received last spring numerous specimens from Mr. Geo. W. Copley, of Alton, and am informed by Mr. J. F. Wielandy, of Jefferson City, Mo., that his father who is a resident of that county has been much troubled with it; yet it has never been heard of in other parts of the State. The only place in which I have, so far, found it in Missouri, is around Eureka, in St. Louis county, where it was first noticed in 1869, but where it occurred the present year in great numbers in two different fields of a white pole bean. It occurs in some parts of Pennsylvania, and is quite common in New York, and to illustrate the amount of damage it is capable of doing, I make room for the following letter, which was received in November, 1870, from Mr. James Angus, of West Farms, N. Y., and which refers to this insect:

I enclose you a sample of beans to show you how thoroughly and effectually this little vagabond is plying his time immemorial avocations in the bean-patches in this quarter. Five or six years ago I had occasion to call on a neighbor, and in passing through the barn he pointed out to me a heap of threshed beans, on the floor, of the Early Mohawk variety, which he said had been destroyed by bugs getting into them since they were threshed. (?) A casual inspection showed that they were destroyed sure enough. At least one-half of them were as badly infested as the sample I send you, but as I pointed out to him, the damage which was now an accomplished fact, had been commenced during the growing season, and the "bugs" were now leaving the beans instead of entering them.

Next season I found a few among my own beans, and they have been on the increase ever since; and this year my Yellow Six Week variety are nearly as bad as my neighbors referred to above. They are nearly as bad this year on a pole variety, the "Dutch Case Knife," as they are on the low growing ones. The small black bush variety, however seems to have escaped them. If some check is not put to their ravages soon, the culture of beans will have to be given up here.

In a short article on this weevil, published by Mr. S. S. Rathvon, in the *American Entomologist*, (Vol. II, pages 118-119,) that gentleman gives the following account of its appearance in his neighborhood:

My specimens evolved in the months of June, July, August and September, from three varieties of the domestic bean (*Phaseolus*,) commonly called "Cranberry," the "Agricultural," and the "Wrens-egg" beans, obtained from Mrs. P. C. Gibbons, Enterprise, Lancaster county, Pa. * * * * I have not yet heard of this insect being found in any other locality in Lancaster county than the one above named. The tenant from whom Mrs. Gibbons received these infested beans has been engaged in the bean culture for twenty-five years on the same farm, and never noticed these weevils until within the last two or three years, and only last year did their destructive character become conspicuously apparent; for out of a small sack of seed-beans hung away, containing less than two quarts, she gathered nearly a teacup-full of the weevils at planting time, in the early part of June, and had all been infested as those were which she brought to me, she could have easily doubled the quantity. About five years ago Mrs. Gibbons received some seed-beans of the "Cranberry" variety, from Nantucket, Mass., and prior to that, she also received some from the Agricultural Department of the Patent Office, and with the one or the other of these, the impression is that the weevils must have been received.

If, as I have supposed (and by perusing what is printed below in small type, the reader will see that no other conclusion can be drawn), this weevil is indigenous; it may possibly occur over large tracts of our country, though the fact that, till a few years ago, it had never been collected by any American entomologist, would strongly intimate that, in what may be termed its wild state, it was quite rare and had a limited range. But even if it should occur in this wild state more generally through the country than the facts would lead us to believe, there is nevertheless more danger of its being introduced into a bean field hitherto exempt by the planting of infested cultivated beans, than by its spreading from the wild food. And if once a few buggy beans are planted, they will in a few years contaminate the other beans cultivated in the neighborhood, so that the man who year after year grows his own seed will suffer as much as the man who originally introduces the weevils from afar.

Except in being smaller, the larva and pupa of this weevil have a close resemblance to those of the Pea-weevil, and its habits are very similar, with the exception that the female deposits a greater number of eggs on a single pod, so that sometimes over a dozen larvæ enter a single bean. I have counted as many as fourteen in one small bean, and the space required for each individual to develop is not much more than sufficient to snugly contain the beetle. The little spot where the Pea-weevil entered can always be detected even in the dry pea, but in the bean these points of entrance become almost entirely obliterated. The cell in which the transformations take place is more perfect and smooth, and the lining is easily distinguished from the meat of the bean by its being more white and opaque. The excrement is yellow or darker than the meat, and even where a bean is so badly infested that the inside is entirely reduced to this excrementitious powder, each larva, before transforming, manages to form for itself a complete cell, which separates it from the rest of its brethren. The eye-spot, as in the pea, is perfectly circular and quite transparent in white-skinned varieties, so that infested beans of this kind are easily distinguished by the bluish-black spots which they exhibit (Fig. 19, *b*). Dark beans when infested are not so easily distinguished.

I have always found the germ either untouched or but partially devoured even in the worst infested beans, so that when but two or three weevils inhabit a bean, it would doubtless grow; but where the meat is entirely destroyed, as it often is, the bean would hardly grow though the germ remained intact, and it would certainly not produce a vigorous plant.

Many of the beetles are perfected in the fall, but many of them not till the following spring, so that there is the same danger of introducing them in seed-beans, as in the case of the Pea-weevil. The remedies and preventives given in the former case will of course apply equally well in this, and I hope that every bean-grower in Missouri who reads this article will make some effort to keep the scourge out of his own neighborhood, by urging upon others, at the Farmers' Club, or at the meetings of any local societies, the necessity of sowing only sound seed, and of thoroughly destroying any that may be received from abroad and found buggy.

Regarding the proper nomenclature of our Bean-weevil, there has been some confusion, and though it has heretofore been considered by several eminent entomologists as the *Bruchus obsoletus* of Say, and I have heretofore, upon insufficient grounds, referred it to that species myself, it nevertheless turns out to be undescribed. In Europe, besides the Grain Bruchus which I just treated of, there are several other species belonging to the same genus which attack beans; but our insect differs from all of them and especially from the Grain Bruchus, to which it has been erroneously referred by Dr. A. S. Packard, Jr.* If it were the imported Grain Bruchus, our peas and some other grains would probably suffer as much from its attacks as our beans, because that species infests peas and other seeds in Europe; but in reality we have no more reason to believe that our Bean-weevil will attack our peas than that the Pea-weevil will attack our beans.

The general color of our Bean-weevil is tawny-gray, the ground-color being dark and the whole body covered with a grayish pubescence which inclines to yellow or fulvous, or wears a slight moss-green hue, and is shaded as in Figure 19, *a*. It is but half the size of the Pea-weevil and has the four or five basal joints and the terminal joint of the antennæ, and the legs, with the exception of the lower and inner part of the hind thighs, reddish-brown.

BRUCHUS FABÆ N. Sp. (Fig. 19,)—General color tawny-gray with more or less dull yellowish. *Body* black tinged with brown and with dull yellowish pubescence, the pygidium and sides of abdomen almost always brownish. *Head* dull yellowish-gray with the jaws dark brown and palpi black; antennæ not deeply serrate in ♀, more so in ♂; dark brown or black with usually 5, sometimes only 4, sometimes 4 and part of 5 basal joints, and with the terminal joint, more or less distinctly rufous, or testaceous, the color being so slight in some specimens as scarcely to contrast at all with the darker joints. *Thorax* narrowed before, immaculate, but with the pubescence almost always exhibiting a single pale medio-dorsal line, sometimes three dorsal lines, more rarely a transverse line in addition, and still more rarely (two specimens) forming a large dark, almost black patch each side, leaving a median stripe and the extreme borders pale and thus approaching closely to *erythrocerus* Dej.; base with the edges almost angulated; central lobe almost truncate and with a short longitudinal deeply impressed median line; no lateral notch; scutel concolorous and quadrate with the hind edge more or less notched. *Elytra* with the interstitial lines having a slight appearance of alternating transversely with dull yellowish and dusky; so slight however that in most of the specimens it can hardly be traced: the dark shadings form a spot on each shoulder and three transverse bands tolerably distinct in some, almost obsolete in others, the intermediate row being the most persistent and conspicuous: between these dark transverse rows the interstices are alternately more or less pale, especially on the middle of the 3rd interstitial lines. *Legs* covered with grayish pubescence, and with the tibiæ and tarsi, especially of first and second pair, reddish-brown; the hind thighs usually somewhat darker, becoming black below and inside, and with a tolerably long black spine followed by two very minute ones. Length 0.09—0.14 inch. Described from 40 specimens all bred from different kinds of beans. Hundreds of others examined.

This insect has been for several years ticketed in some of the Eastern collections by the name of *B. fabæ*, or else, what is worse, the corruption of it, *fabi*. The former name has been disseminated by my friend F. G. Sanborn of Boston, Massachusetts, who says that he received the weevil thus named, together with beans attacked by it, in the year 1862 from Rhode Island. The name was credited to Fabricius, but I can find no notice in any of the works I possess of any European *Bruchus fabæ*, and several of my Eastern correspondents who have access to large libraries have been unable to find any description or allusion to a species by that name. Dr LeConte has given it the MS name of *varicornis* but as his description will not appear perhaps for years to come and as no comprehensive description has yet been published, I have deemed it advisable to dispel in a measure the confusion that surrounds the nomenclature of the species. There is need of a description of so injurious an insect, and as *fabæ* is not preoccupied I adopt the name because it is entirely appropriate and because it is more easily rendered into terse popular language that *varicornis*. †

* Injurious insects new and little known, pp. 19–21.

† No one can have a greater regard than I have, for the work of our great Coleopterist, Dr. LeConte, who is justly looked up to as our authority in his specialty; and for no other reason than the one given above would I venture to disregard even one of his manuscript names. Were he now at home, I should have corresponded with him on the subject, and I feel satisfied that he would have sanctioned this course. These remarks are prompted by the fact that certain entomolo-

It resembles most closely of any other species which I have seen, the *B. erythrocerus*, Dej., which, however, is smaller, and differs in having a narrower thorax which has light sides and a dark, broad dorsal stripe divided down the middle by a pale narrow line: *erythrocerus* is further distinguished by the antennæ being entirely testaceous and the hind thighs more swollen.

From *obsoletus* Say, *fabæ* differs materially: *obsoletus* is a smaller species, dark gray, with the antennæ all dark, the pygidium not rufous, the thorax with a perceptibly darker dorsal shade so that the sides appear more cinereous, a white scutel, and each interstitial line of the elytra with a slight appearance of alternating whitish and dusky along its whole length; for though there is nothing in Say's language to indicate whether it is the interstitial lines that alternate transversely, whitish and dusky, or each line that so alternates longitudinally, I find from an examination of a specimen in the Walsh collection, that the latter is the case, and so much so that the insect almost appears speckled. The two species differ both in size and color, though, as Say's description is short and imperfect it is not surprising that *fabæ* should have been referred to it.

From the European bean-feeding *Br. flavimanus* (which is apparently either a clerical error for, or a synonym of *Br. rufimanus*, Schœnh.) as described by Curtis, it differs notably; as it does likewise from their *Br. serratus*, Ill., which also attacks beans.

Dr. LeConte, according to Mr. Rathvon, was inclined to consider this insect the *obsoletus* of Say, from the fact that in specimens which the latter gentleman sent him, the antennæ were not varied as in his MS. *varicornis*, but uniformly black. A few specimens which Mr. Rathvon sent me nearly two years ago, taken from the same lot as were those which he forwarded to Dr. LeConte, were singularly enough, all decapitated but two; and these two showed the varied antennæ. These specimens had all been kept in alcohol, and I am greatly inclined to believe that the uniformly dark appearance of the antennæ that was noticed by LeConte was the effect of the alcohol on those which naturally had the rufous joints but faintly indicated. At all events, though Mr. Rathvon tells me that he found a small proportion of beetles with dark antennæ, after examining, at my suggestion, over two hundred specimens that had thus been kept in alcohol; yet from over one hundred specimens which he had the kindness to send me, I only find (after thoroughly drying them) three with the terminal joint really as dark as the subterminal, and not a single one in which the rufous basal joints cannot be more or less distinctly traced.

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gists have objected to isolated descriptions of insects, on the plea that they cause confusion and an unnecessary synonymy in our nomenclature. There is, in fact, a certain class of persons—and they have been aptly termed closet-entomologists—who manifest a superlative contempt for anything that does not appear in the transactions or publications of some scientific society; and they even claim that the descriptions which have appeared in State Entomological Reports are invalid and should be disregarded. The descriptions of Dr. Fitch, and many of those of the late Mr. Walsh, and my own, would of course come under this head. It is a little significant, however, that the very persons who manifest such a contempt for scientific work, whenever it is combined with the practically useful, are the very ones who indulge in the fatal monomania for grinding out new species from the mere comparison of a few more or less damaged specimens of the perfect insects, obtained nobody knows how, when or where; and without even the slightest knowledge of the larval and pupal history and the general habits of the so-called species. They make species out of the slightest individual variation, and even erect genera upon a slight individual difference in the size or shape of the wing. So baseless a system must necessarily be fraught with great scientific untruthfulness, and is well calculated to disgust the student who endeavors to rightly interpret the significances in Nature. An immense number of the published descriptions in the Class of insects in this country are based upon the simple examination of solitary specimens of the perfect insects, without the fact being mentioned, and are therefore not in any true sense of the term descriptions of species, but mere descriptions of individuals. The few men whose sole ambition seems to be to attach their names to as many of these so-called species as possible, are the ones who are most inclined to sneer at, and treat lightly the honest work of more practical men—forgetting that science does not consist of mere classification and orderly arrangement, but that she wears a nobler mien when applied to penetrating and comprehensive search after Nature's truths.

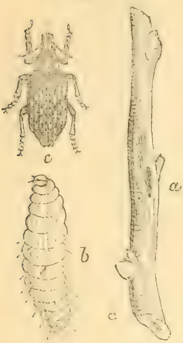
A truth is equally scientific, whether published in a plain, practical work, or in the drier pages of the transactions of some august scientific body; and so far as the science of entomology is concerned, it will certainly be more advanced by the full and comprehensive description of a species, albeit such description be clothed in plain terms and published in a popular work, than by a less complete and more confused description, in the transactions of an Entomological Society; and provided it is published in a work essentially entomological, the monographer will certainly prefer the former to the latter. In the past, science belonged to the few, and was always paraded before the world in as unattractive and technical a form as possible. To-day she is fast becoming the property of the multitude, and should be popularized as much as possible; for it is folly to suppose, as some men do, that in science "popular" and "inaccurate" are synonymous terms, simply because some writers have failed to combine the scientifically accurate with the popular and practical.

The entomologist who occupies himself with the habits of insects, cannot well become a systematist, and would far sooner accurately describe the hitherto unknown habits and transformations of a single common species, than describe a dozen new ones. He may have hundreds of new species in his cabinet; but these he prefers to turn over to the specialist, whose work he fully appreciates and whose aid he must often seek. When, however, in the course of his work, he is obliged to publish an isolated description, the specialist proper should certainly not depreciate his labor, providing it is well performed.

THE NEW YORK WEEVIL—*Ithycerus noveboracensis*, Forster.

The large gray beetle represented at *c*, in the accompanying cut often does considerable damage to fruit trees, and I continually receive it every spring by persons who desire to know more of its habits. It kills the twig by gnawing off the tender bark, in the early part of the season before the buds have put out, and later in the year it destroys the tender shoots which start out from old wood, by entirely devouring them. It eats out the buds and will also frequently gnaw off the leaves at the base of the stem, after they have expanded. It attacks, by preference, the tender growth of the Apple, though it will also make free with that of Peach, Plum, Pear and Cherry, and probably of other fruit as well as forest trees. It is the largest snout-beetle which occurs in our State. and with the rest of the species belonging to the same genus (*Ithycerus*=straight-horn) it is distinguished from most of the other snout-beetles by the antennæ or feelers being straight instead of elbowed or flail-shaped as they are in the common Plum Curculio, for instance. The specific name *noveboracensis* which means "of New York" was given to this beetle just 100 years ago by Forster, doubtless because he received his specimens from New York. But like many other insects which have been honored with the name of some Eastern State, it is far more common in the Mississippi Valley than it is in the the State of New York, it scarcely being known as an injurious insect in the East. It was subsequently described as *Pachyrhynchus Schœnherri* by Mr. Kirby. The general color of the beetle is ash-gray, marked with black as in the cut (Fig. 20, *c*), and with the scutel or small semi-circular space immediately behind the thorax, between the wings, of a yellowish color. Its larval habits were for a long time unknown, but two years ago I ascertained that it breeds in the twigs and tender branches of the Bur oak, and have good reason to believe that it also breeds in those of the Pignut hickory. The female in depositing, first makes a longitudinal excavation with her jaws (Fig. 20, *a*) eating upwards under the bark towards the end of the branch, and afterwards turns round to thrust her egg in the excavation. The larva, (Fig. 20, *b*) hatching from the egg is of the usual pale yellow color with a tawny head. I have watched the whole operation of depositing, and, returning to the punctured twig a few days after the operation was performed, have cut out the young larva; but I do not know how long a time the larva needs to come to its growth, nor whether it undergoes its transformations within the branch, or leaves it for this purpose to enter the ground; though the former hypothesis is the more likely.

[Fig. 20.]



This insect is more active at night than during the day, and is often jarred down upon the sheet or the Curculio-catcher, for it falls about as readily as the Plum Curculio.

The destructive pear blight, otherwise known as fire-blight, has been attributed to a peculiar poisonous fluid which this beetle secretes and with which it poisons the wood.* I have never noticed any such secretion, and feel quite convinced that it has nothing to do with the real pear blight (and there are more than one kind) which is very justly considered by the most eminent horticulturists of the land to be of fungoid rather than insect origin. It is quite probable that the beetle secretes some such fluid which causes a sort of blight, because several bark-boring and wood-boring beetles are known to produce such an effect; but this insect-blight must not be confounded with the far more subtle and destructive Pear Blight, so called.

THE IMBRICATED SNOUT-BEETLE—*Epicærus imbricatus*, Say.

This is another insect, which is quite frequently met with on our different fruit trees, doing considerable injury to apple and cherry trees and gooseberry bushes, by gnawing the twigs and fruit. Its natural history is, however, a sealed book, and I introduce it at present more to draw the attention of orchardists to this fact than to give any information with regard to it. The beetle is a native of the more Western States and is found much more commonly in the western part of the State, in Iowa, Kansas, and towards the mountains than it is on the eastern side of the great Father of Waters.

[Fig. 21.]

The general color is a dull silvery-white with brown markings as in the figure (Fig. 21), which are sometimes dark and distinct, and at others almost obsolete. Indeed the species is so variable that it has received no less than four distinct names, *i. e.* four distinct species have been fabricated out of one.†

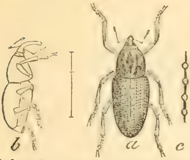
*See a communication from H. H. Babcock, of Chicago, in the *Am. Entomologist and Botanist*, Vol. II, p. 176.

†There can be no doubt of this, for the range of variation is so great that specimens agreeing in every respect with *imbricatus*, *fornudolosus*, *vadosus* and *fallax*, are to be met with in very limited localities; and both Dr. LeConte and Mr. Walsh were of opinion that these four so-called species were but varieties.

THE CORN SPHENOPHORUS—*Sphenophorus zeæ*, Walsh.

In the last number of the *Practical Entomologist*, Mr. Walsh gave the first account of a weevil which in certain years does great damage to the corn crop by puncturing the young plant near the ground, and riddling it with holes of about the size that an ordinary pin would make. They may even be found under ground attached firmly to the stalk, and when numerous enough the plant always dies.

[Fig. 22.]



The color of the beetle is brown-black or black, often obscured by yellowish or grayish matter adhering to, and filling up the hollow punctures. Figure 22 gives a good illustration of it, *a* showing a shaded back view, *b* an outline side view, and *c* showing the manner in which the wing-covers are punctured. The original description as given by Mr. Walsh will be found below.

In the spring of 1868, Mr. L. V. Smith, of Geneva, Ontario county, N. Y., sent me numerous specimens; and I have often found it in great numbers on the lake-beach at Chicago, though it does not seem to be common in our own State. But it is well that corn-growers be made familiar with its appearance.

The larval history of this weevil is unknown, but there seems good reason to believe that it breeds in rotting and moist wood, situated in places where it is constantly washed by the water; for the beetles, with others belonging to the same genus are found in such situations and in decayed logs floating in swamps. If this supposition be the correct one—and the fact that it has been injurious only in the immediate neighborhood of rivers and lakes adds great weight to such a supposition—then this weevil will not be likely to multiply unduly where there are not large bodies of water.

"SPENOPHORUS ZEÆ, new species? Color black, often obscured by yellowish matter adhering to the hollow places, which, however, can be partially washed off. Head finely punctured towards the base, with a large dilated puncture between the eyes above. Snout one-third as long as the body, of uniform diameter, as fine as a stout horse-hair, and curved downwards. Before the middle of the thorax a polished diamond-shaped space, prolonged in a short line in front and in a long line behind; and on each side of this an irregularly defined polished space, somewhat in the form of an inverted Y; the rest of thorax occupied by very large punctures, which fade into finer and sparser ones on the polished spaces. Wing-cases with rows of still larger punctures, placed very wide apart in the usual grooves or striæ; the sutural interstice, that between the 2nd and 3rd striæ, and that between the 4th and 5th striæ wider than the rest, elevated, and occupied by very fine punctures; a small elongate-oval polished spot on the shoulder and another near the tip of the wing-case. Beneath, polished, and with punctures as large as those of the thorax.—Length about three-tenths of an inch, exclusive of the snout. Comes very near *Sphenophorus truncatus* Say, but the snout is not "attenuated at tip" and has no "elongated groove at base above;" and moreover, nothing is said in the description of that species of the very large and conspicuous punctures, found in the elytral striæ of our species."

THE COCKLEBUR SPHENOPHORUS—*Sphenophorus pulchellus*, Schœnherr.

[Fig. 23.]

In closing this chapter on snout-beetles I introduce this species (Fig. 23, *a* shaded back view; *b* outline side-view,) not that it is injurious, but because it belongs to the same genus, and is closely allied to the preceding insect; and because its larval habits, which are now given for the first time, may lead us more readily to discover those of its more injurious ally.

The color of this beetle above, is of a deep brick-red inclining to blood-red, often with a tinge of orange, and it is marked with black as in the figure, the whole underside being also black. The larva bores the stalks of the common cocklebur (*Xanthium strumarium*,) and differs from most other snout-beetle larva in having a dark mahogony-brown head, and in the anal joint being slantingly truncated and furnished with fuscous elevations which give rise to short stiff bristles. It transforms in the fall of the year within the stem and issues as a beetle about the end of September.*

Of our other N. A. snout-beetles may be mentioned as especially injurious the Grape Curculio (*Caliodes inæqualis*, Say), Grape-cane Curculio (*Baridius sesostris*, Lec.) Potato-stalk weevil (*Baridius trinotatus*, Say), the different nut-weevils (genus *Balaninus*), the Grain-weevil (*Sitophilus granarius*, Linn.), the White-pine weevil (*Pissodes strobi*, Peck), and the Cranberry-weevil (*Anthonomus suturalis*, Lec.) The first three have already been treated of in my first Report, the nut-weevils will form the subject of a future article, and the others have either been fully treated of in standard works or are not particularly injurious in Missouri.

*This insect seems to differ from 13-*punctatus*, Say, in absolutely nothing but in having a large black patch at the tip of the elytra instead of two spots. I have bred four specimens from cocklebur, and they are all tolerably constant in the characters accorded to *pulchellus*. But I am strongly of opinion that we have to deal here with but one species, and that with a sufficiently large series, the dividing line could not be drawn. At all events 13-*punctatus* is very variable in the size of its spots, and the greatest variation occurs in these two at the tip of the elytra, while Say describes and figures a variety of his 13-*punctatus* which is singularly intermediate between the two species. In three specimens of 13-*punctatus* in my cabinet, the two posterior spots are so large that they almost meet, while in some specimens they are not larger than the other elytral spots.

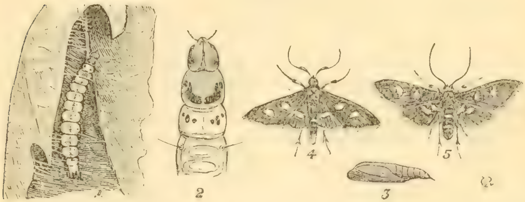
INSECTS INJURIOUS TO THE GRAPE-VINE.

The following articles under this head are a continuation of the series began in my first and continued in my second Report, and I shall continue the series until all the insects of any note, which affect the Grape-vine, shall be treated of.

THE GRAPE LEAF-FOLDER—*Desmia maculalis*, Westw.

(Lepidoptera, Asopidæ.)

[Fig. 24.]



The subject of this sketch has long been known to depredate on the leaves of the Grape-vine in many widely separated parts of North America. It is not uncommon in Canada West, and is found in the extreme southern parts of Georgia. It appears to be far more injurious, however, in the intermediate country, or between latitude 35° and 40°, than in any other sections, and in Southern Illinois and Central Missouri proves more or less injurious every year. It was first described and named by Westwood,* who erected, for it, the genus *Desmia*.

The genus is characterized by the elbowed or knotted appearance of the ♂ antennæ, in contrast with the smooth, thread-like ♀ antennæ; the maxillary palpi are not visible, while the compressed and feathery labial palpi are recurved against the eyes, and reach almost to their summit; the body extends beyond the hind wings.

The moth of the Grape Leaf-folder is a very pretty little thing, expanding on an average almost an inch, with a length of body of about one-third of an inch. It is conspicuously marked, and the sexes differ sufficiently to have given rise to two names, the female having been named *Botys bicolor*. The color is black with an opalescent reflection, and the under surface differs only from the upper in being less bright; all the wings are bordered with white. The

* Mag. Zool., par M. Guérin, 1831; pl. 2.

† Mr. Glover, in the Agricultural Report for 1854, p. 79, says that the male has a semi-lunar mark of white on the outside of each spot, which in his figure, pl. 6, ibid., is very distinct. In dozens of specimens bred in Illinois and Missouri no such mark appears, though there is an apparent coincident shade, barely distinguished from the black ground-color, on the outside of each spot in both male and female.

front wings of both sexes are each furnished with two white spots;† but while in the male (Fig. 24, 4) there is but one large spot on the hind wings, in the female (Fig. 24, 5) this spot is invariably more or less constricted in the middle, especially above, and is often entirely divided into two distinct spots. The body of the male has but one distinct transverse band, and a longitudinal white dash at its extremity superiorly, while that of the female has two white bands. The antennæ, as already stated, are still more characteristic, those of the male being elbowed and thickened near the middle, while those of the female are simple and thread-like.

There are two broods in this latitude—and probably three farther south—during the year; the first moths appearing in June, the second in August, and the worms produced from these last hibernating in the chrysalis state. The eggs are scattered in small patches over the vines, and the worms are found of all sizes at the same time. These last change to chrysalids in 24 to 30 days from hatching, and give forth the moths in about a week afterwards.

The worm (Fig. 24, 1) folds rather than rolls the leaf, by fastening two portions together by its silken threads; and for this reason, in contradistinction to the many leaf-rollers, may be popularly known as the "Grape Leaf-folder." It is of a glass-green color,* and very active, wriggling, jumping and jerking either way at every touch. The head and thoracic segments are marked as at Figure 24, 2. If let alone, these worms will soon defoliate a vine, and the best method of destroying them is by crushing suddenly within the leaf, with both hands. To prevent their appearance, however, requires far less trouble. The chrysalis is formed within the fold of the leaf, and by going over the vineyard in October, or any time before the leaves fall, and carefully plucking and destroying all those that are folded and crumpled, the supply for the following year will be cut off. This should be done collectively to be positively effectual, for the utmost vigilance will avail but little if one is surrounded with slovenly neighbors.

I believe this insect shows no preference for any particular kind of grape-vine, having found it on well nigh all the cultivated as well as the wild varieties. Its natural enemies consist of spiders, wasps, and a small undescribed species of *Tachina*-fly which I have ascertained to infest it in the larva state, and to which I have given the MS. name of *desmiæ*. There is every reason to believe that it is also attacked by a small clay-yellow beetle, the Grape-vine Colaspis

* I subjoin a description of this worm, as first given by me in the Prairie Farmer Annual for 1868. Average length, 0.80. Largest on abdominal joints, and tapering thence slightly each way. Color glass-green, always darker above than below. A narrow darker dorsal line, with each joint swollen into two transverse wrinkles. Laterally paler or yellowish, and a large and distinct piliferous spot on each joint, with others scarcely visible with a lens. Head fulvous, polished, horizontal, with two small eyespots and two larger dark patches. Joint 1 of the same color, and marked as in Figure 24, 2. Joint 2 has two small spots, with an intermediate larger one, on each side. Legs yellowish. Acquires a carneous or pink tint before changing to chrysalis, which latter is of the normal color, size and form of Figure 24, 3, and has at the tail several very minute curved hooks, joining and forming into a point.

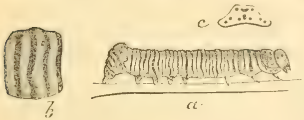
(*Colaspis flavida*, Say,) which is described further on, and which, though a vegetable feeder, may often be found in the fold of the leaf in company with some shrunken, half-dead worm.

THE GRAPE-VINE EPIMENIS.—*Psychomorpha epimenis*, Drury.

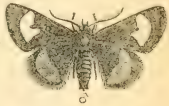
(Lepidoptera Zygænidæ.)

Under the head of "Blue Caterpillars of the Vine," an account was given in my last Report (pp. 83–5) of the Pearl Wood Nymph, (*Eudryas unio*, Huebner), and of what I thought there was good reason to believe was its larva, namely, the smaller of the blue caterpillars (Fig. 25, *a* full grown caterpillar; *b* enlarged side view of one of the joints; *c* enlarged hump on the 11th joint). I have since been able to decide definitely as to the character of this larva, having bred numerous specimens to the perfect state. It turns out to be an entirely different insect to what I had conjectured, and produces a beautiful little moth (Fig. 26), which may be known to the grape-grower as the Grape-vine Epimenis.

[Fig. 25.]



[Fig. 26.]



This moth is most strikingly marked and bears no resemblance whatever to the Pearl Wood Nymph. Its color is deep velvety-black with a broad irregularly lunate white patch across the outer third of the front wings, and a somewhat larger, more regular patch of orange-red or brick-red on the hind wings. The underside is similarly marked, but that of the front wings is less velvety with two additional white spots inside near the costa, the outer one generally, and sometimes both of them, connected with the broad white patch. Especially is this the case in the males; the wing appearing to have a large triangular white patch with two quadrate black spots in it connected with the costa. The wings are beautifully tinselled with steel-blue, or purplish scales, which form a narrow band near the outer margin of each and appear more or less distinctly on the basal half of the front wings. On the under side the steel-blue is especially conspicuous on the costa and hind border of the hind wings. In old specimens the scales get much rubbed off and the general color appears duller and more brown. The antennæ of the female are thread-like and with alternate black and white scales. Those of the male are beautifully and broadly toothed on two sides, or bi-pectinate, and he is furthermore distinguished from the female by the more uniform diameter of his abdomen which is slightly tufted and squarely cut off at the apex.

A full account was given of the larva in the article already referred to, and the proper remedy for its injuries suggested, so that I shall simply add below a technical description of it. Its habit of boring into some substances to prepare for the change to pupa, is inveterate, and it always neatly covers up the orifice so that it is difficult to detect. I have had over a dozen of them enter a single cork but 1¼ inches in diameter and about an inch deep; and such a cork, if given during May of one year to an uninitiated person, with instructions to keep it in a glass vessel, will cause much surprise and interest the following March when the moths will begin to issue from it.

Dr. Melsheimer* wrote to Dr. Harris on the 28th of February, 1840, that he had bred this moth from the larva, and rightly states that recent specimens are not brown, and that the larva is a half looper; but he does not mention its food-plant. Dr. Packard,† who does not mention the sexual differences, quotes Harris as stating on the authority of Abbott, that the larva feeds on the wild Trumpet-creeper (*Bignonia radicans*) in Georgia. But no one has heretofore mentioned its Grape-vine feeding propensities, and it is consequently now added for the first time to our list of Grape-vine depredators, and there are four instead of three bluish caterpillars, all bearing a close general resemblance, which feed upon that plant. They all occur in Missouri, but the present species is far more numerous and destructive than the other three put together. I have now described three of them, and shown wherein they differ from one another, and the fourth, namely, the larva of the Pearl Wood Nymph, is said by Dr. Fitch to so closly resemble that of the Beautiful Wood Nymph that we know not yet whether there are any distinguishing characteristics between them.

PSYCHOMORPHA EPIMENIS, Drury—*Larva.*—General appearance bluish. The ground-color is however pure white, and the apparent bluish cast is entirely owing to the ocular delusion produced by the white with the transverse black bands as in *Alypia octomaculata.* Transversely banded with four black stripes to each joint, the third and fourth being usually rather wider apart than the other two, and diverging at the lower sides where they make room for two more or less conspicuous dark spots placed one below the other; the third on some of the middle joints is frequently broken, with an anterior curve, just above stigmata, and on joints 2 and 3 it is twice as thick as the rest. Cervical shield, hump on joint 11, anal plate, legs and venter, dull pale orange. Joint 1 with about 14 large shiny piliferous black spots, 8 of which form two rows on the cervical shield (those in the anterior row being largest and farthest apart,) and six of which are lateral, namely, three each side, with more or less distinct dusky marks between and in front of them. The spots on the hump are usually placed as at Figure 26, *c*, but vary very much, though the four principal ones on the top are generally placed in a square. The anal plate is marked with 8 such spots, very much as in the cervical shield, but smaller. The tips of the thoracic legs are black and the other legs and venter are also spotted. Head gamboge-yellow, inclining to orange, with 8 principal and other minor black piliferous spots. The ordinary piliferous spots are small, and except two dorsal ones which are in the white space between the second and third band, they are not easily detected. The stigmata are also quite small and round. The abdominal prolegs de-

* Harr. Corr., p. 111.
† Guide, etc., p. 281.

crease in size from the last to the first pair, and the larva curves the thoracic joints and is a half-looper, especially when young. Average length about one inch. Described from numerous specimens.

Chrysalis.—Average length 0.37 inch; reddish-brown; rugose, especially on dorsum of abdominal joints, but distinguished principally by the truncated apex, which has a large horizontally compressed ear-like horny projection at each upper and outer edge.

THE GRAPE-VINE PLUME—*Pterophorus periscelidactylus*, Fitch.

(Lepidoptera, Alucitidæ.)

In my first Report a short account has already been given of this insect, but as it was very numerous last spring, and as I had good opportunities of making further observations, I have concluded, by aid of the accompanying figure, to give a more complete account of it.

[Fig. 27.]

In the earlier published Proceedings of our State Horticultural Society reference is occasionally made to "small grey or green worms which feed on the young leaves before blossoming,"* without any definite name being given to them. Husmann, in his "Grapes and Wine," (p. 80) mentions similar worms, and I have little doubt but that the insect referred to is the little Plume we are now considering.

Just about the time that the third bunch of grapes, on a given shoot, is developing, many of the leaves, and especially those at the extremity of the shoot, are found fastened together more or less closely, but generally so as to form a hollow ball. These leaves are fastened by a fine white silk, and upon opening the mass and separating the leaves, one of two caterpillars will generally be found in the retreat. I say one of two, because the retreat made by the smallest of the Blue Caterpillars of the Vine, namely, the larva of the Grape-vine Epimenis (Fig. 26, *a*) which we have just treated of, so closely resembles that of the Grape-vine Plume under consideration, that until the leaves are separated it is almost impossible to tell which larva will be found. Both occur at the same time of year, and both were more destructive than usual the past season in the vicinity of St. Louis. In an ordinary season they do not draw together the tips of the shoots till after the third bunch of grapes is formed, and in devouring the terminal bud and leaves, they do little more than assist the vineyardist in the pruning

* Proceedings for 1860, p. 58, and 1861–2, p. 77.

which he would soon have to give. They act, indeed, as Nature's pruning-knives. But the late and severe frost which killed the first buds last April, so retarded the growth of the vines that the worms were out in force before the third bunch had fully formed, and this bunch was consequently included in the fold made by these worms, and destroyed.

The larva of the Grape-vine Plume invariably hatches soon after the leaves begin to expand; and though it is very generally called the Leaf-folder, it must not be confounded with the true Leaf-folder, which was just now described, and which does its principal damage later in the season. At first the larva of our Plume is smooth and almost destitute of hairs, but after each moult the hairs become more perceptible, and when full grown the larva appears as at Figure 27, *a*, the hairs arising from a transverse row of warts, each joint having four above and six below the breathing-pores * (see Fig. 27, *c*). After feeding for about three weeks, our little worm fastens itself securely by the hind legs to the underside of some leaf or other object, and, casting its hairy skin, transforms to the pupa state. This pupa (Fig. 27, *b*), with the lower part of the three or four terminal joints attached to a little silk previously spun by the worm, hangs at a slant of about 40°. It is of peculiar and characteristic form, being ridged and angular, with numerous projections, and having remnants of the larval warts; it is obliquely truncated at the head, but is chiefly distinguished by two compressed sharp-pointed horns, one of which is enlarged at Figure 27, *c*, projecting from the middle of the back; it measures, on an average, rather more than one-third inch, and varies in color from light green with darker green shadings, to pale straw-color with light brown shadings.

The philosophic student of insect life cannot fail to be struck with the wonderful disguises which these little animals often assume, the better to escape detection from their enemies. The instances of protective mimicry are more numerous among insects than among any other Class of animals, and in the last part of this Report, I shall have occasion to refer to this subject more fully. I had often wondered why the pupa of the Grape-vine Plume was seldom noticed in the open vineyard, and I very well recollect, when three years ago, this worm was abundant in the vineyard of the Rev. Charles Peabody of Glenwood, I. M. R. R., that he one day expressed great astonishment at their total and sudden disappearance. I told him that

* As Dr. Fitch's description of this larva is the only one I know of, and is rather incomplete, I subjoin the following for the scientific reader:

MATURE LARVA OF PTEROPHORUS PERISCELIDACTYLUS.—Average length 0.50 inch. Color pale greenish-yellow. Joints separated by deep constrictions. Each joint with a transverse row of large cream-colored warts, giving rise to soft white hairs, many of which are slightly clubbed at tip. Four of these warts above, and six below stigmata, the four lower smaller than the six upper ones. The hairs from warts above stigmata diverging in all directions and straight, those from the row immediately below stigmata decurving. Other short and more minute club-tipped hairs spring from the general surface of the body between the warts. Head yellow, with labrum slightly tawny. Legs also yellow, immaculate and very long and slender. Described from numerous living specimens.

they had changed to the pupa state and were more thoroughly hidden among the leaves; but he did not succeed in feeding any of the pupæ, and I did not then suspect that we have here a case of mimicry. From some interesting facts communicated to me by Mr. M. C. Read of Hudson, Ohio, I am atisfied, however, that we have here a clear case of protective disguise. He says: "Of a large number raised in jars by me, there were two well defined colors, one a reddish-brown resembling closely the bark of ripe grape wood, the other a light green, or exactly the color of the leaves and young wood. Without an exception the green ones were attached to the green leaves and green wood, or to the sides of the glass jar of very similar color; while all of the brown ones were attached to stems of the ripened grape-wood." Having noted this fact he put large numbers of larvæ in a jar with sticks and material of various colors, but he obtained only the two varieties of pupæ and each was invariably attached to an article of the same color as itself.

So far as I recollect the facts noticed in my own breeding of this insect, they accord with the observations of Mr. Read, and there is no reason to doubt that in a state of nature the green variety confines itself to the leaves, and the brown variety to the wood of the vine. Upon the theory of Natural Selection, *i. e.*, in this case, the preservation of the best disguised specimens, these facts become significant, and it is easy to understand how the two distinct forms would in time inevitably be produced; but whether these singular disguises be explained on that theory or on any other, they are equally interesting and afford good food for the reflective mind.

The moth (Fig. 27, *d*) escapes from this pu a in about one week, and, like all the species belonging to the genus, it has a very active and impetuous flight, and rests with the wings closed and stretched at right angles from the body, so as to recall the letter T. It is of a tawny yellow color, the front wings marked with white and dark brown as in the figure, the hind wings appearin like burnished copper, and the legs being alternately banded with white and tawny yellow.

All the moths of the family (Alucitidæ) to which it belongs have the wings split up into narrow feather-like lobes, and for this reason they have very appropriately been called Plumes in popular language. In the genus *Pterophorus* the front wings are divided into two, and the hind wings into three lobes. As I have shown in my first Report we have a somewhat larger species (*P. carduidactylus*, Riley) which occurs on the Thistle, and which, though bearin a close resemblance to the Grape-vine Plume in color and markings, yet differs very remarkably in the larva and pupa states.

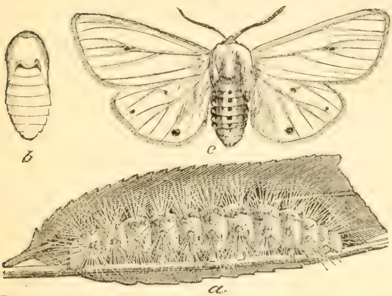
From analogy we may infer that there are two broods of these worms each year, and that the last brood passes the winter in the moth state. I have, however, never noticed any second appearance of them, and whether this is from the fact that the vines are covered with a denser foliage in the summer than in the spring, or whether there is really but one brood, are points in the history of our little Plume which yet have to be settled by further observation.

On account of its spinning habit, which enables us to detect it, this insect is easily kept in check by hand picking.

THE COMMON YELLOW BEAR—*Spilosoma virginica*, Fabr.

(Lepidoptera, Arctiidæ.)

[Fig. 28.]



This is one of the most common North American insects. The moth (Fig. 28, *c*) which is very generally dubbed "the Miller," frequently flies into our rooms at night; and there are quite a number of our farmers who, somehow or other, have got the idea that this "Miller" is the insect that infests their bee-hives—that it is, in short, the Bee-moth. Of course no such ridiculous idea could for a moment prevail among those who read these Reports.

Though the moth is so common, how few persons ever think of it as the parent of that most troublesome of caterpillars, which Harris has so aptly termed the Yellow Bear (Fig. 28, *a*). These caterpillars are quite frequently found on the Grape-vine, and when about one-fourth grown bear a considerable resemblance to the mature larva of the Grape-vine Plume which we have just described. They seldom appear, however, till that species has disappeared, and may always be distinguished from it by their semi-gregarious habit at this time of their life, and by living exposed on the leaf (generally the under side) instead of forming a retreat within which to hide themselves, as does the Plume.

The Yellow Bear is found of all sizes from June to October; and though quite fond of the vine, is by no means confined to that plant. It is, in fact, a very general feeder, being found on a great variety of herbaceous plants, both wild and cultivated, as butternut, lilac, beans, peas, convolvulus, corn, currant, gooseberry, cotton, sunflower, plantain, smart-weed, verbenas, geraniums, and almost any plant with soft, tender leaves. These caterpillars are indeed so indifferent as to their diet, that I have actually known one to subsist entirely, from the time it cast its last skin till it spun up, on dead bodies of the Camel Cricket (*Mantis carolina*).

When young they are invariably bluish-white, but when full-grown they may be found either of a pale cream-color, yellow, light brown or very dark brown, the different colors often appearing in the same brood of worms, as I have proved by experiment. Yellow is the most common color, and in all the varieties the venter is dark, and there is a characteristic longitudinal black line, more or less interrupted, along each side of the body, and a transverse line of the same color (sometimes faint) between each of the joints: the head and feet are ochre-yellow, and the hairs spring from dark yellow warts, of which there are 10 on each joint, those on joint 1 being scarcely distinguishable, and those on joint 12 coalescing. There are two broods of these worms each year, the broods intermixing, and the last passing the winter in the chrysalis state. The chrysalis (Fig. 28, *b*) is formed in a trivial cocoon, constructed almost entirely of the caterpillar's hairs, which, though held in position by a few very fine silken threads, are fastened together mainly by the interlocking of their minute barbs, and the manner in which the caterpillar interweaves them.

The moth makes its appearance as early as the first of May in the latitude of St. Louis, but may often be found much earlier in stove-warmed rooms. It is easily recognized by its pure white color, by its abdomen being orange above, with three rows of black spots, and by the black dots on its wings. These dots vary in number, there being usually two on each of the front and three on each of the hind wings, though sometimes they are all more or less obsolete, except that on the disk of the front wings.

It is fortunate for us that this caterpillar is attacked by a large number of insect parasites; for, were this not the case, it would soon multiply to such a degree as to be beyond our control. I know of no less than five distinct parasites which attack it—some living singly in the body of the caterpillar, and issuing from the chrysalis without spinning any cocoon of their own; others living singly in the body, but forming a cocoon of their own inside the chrysalis of their victim, and still others infesting the caterpillar in great numbers, and completely filling the chrysalis with their pupæ.*

The best time to destroy these worms is soon after they hatch from their little round yellow eggs, which are deposited in clusters; for, as already intimated, they then feed together.

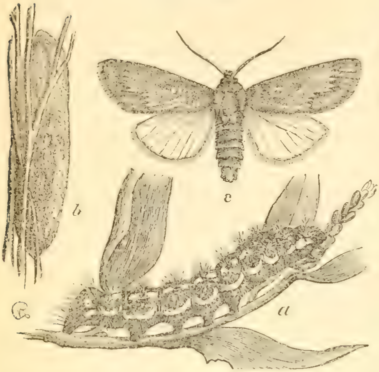
* For the benefit of the scientific reader I enumerate the five parasites which I have ascertained to infest this caterpillar: 1. *Anomalon flavicorne* (Brullé Hym IV, p. 171). 2. *Ichneumon subcyaneus*, Cress. (Proc. Ent. Soc., Phila., III, p. 148), and *Ich. pullatus*, Cress. (Pro. E. S. P., III, p. 146), described as a distinct species, but *pullatus* is evidently the male, and *subcyaneus* the female of the same species, as I have bred from *Spilosoma virginica* three males all answering to the description of the former, and two females both answering to the description of the latter. 3. *Ichneumon signatipes*, Cress. (Trans. Amer. Ent. Soc,, I, p. 308). 4. *Ophion bilineatus*, Say. (Ent. of N. A., I, p. 379). 5. A small undetermined, and probably undescribed Dipteron belonging to the MUSCADÆ.

THE SMEARED DAGGER—*Acronycta oblinita*, Sm. & Abb.

(Lepidoptera, Acronyctidæ.)

This is another insect which is occasionally found upon the Grape-vine, but never in sufficient numbers to do any considerable harm. It is one of our most common insects, and a very g[illegible]al [illegible]d[illegible]r [illegible]ccurring on a great variety of herbaceous plants, among others asparagus and cotton, and being especially partial to the common smart-weed (*Polygonum hydropiper*). It also feeds on some shrubs and trees, occasionaly proving q[illegible] [illegible]jurious, for Mr. F. A. Nitchy, of Jefferson City, sent me specimens last summer with the statement that they were very numerous on his peach trees, and I have known it to denude both apple and willow trees.

[Fig. 29.]



The larva (Fig. 29, *a*) is easily recognized by the distinct wavy bright yellow band at the side, and the transverse row of crimson-red warts and stiff yellowish or rust-red bristles across each joint, in contrast with the black color of the body. When full grown it draws a few leaves or stems together, or retreats into some fence corner, and spins a narrow elongated cocoon (Fig. 29, *b*) generally white, but occasionally inclining to ochre-yellow, some which I have found on Willow being of this last color. The chrysalis is very dark brown, and, with the exception of a smooth shiny band on the posterior border of each abdominal joint, is rough or shagreened. It has the power of violently turning round and round in its cocoon when disturbed, thereby causing a rustling noise. The moth (Fig. 29, *c*) has the front wings of an ash-gray color, caused by innumerable dark atoms scattered over a white ground, and there is a distinct row of black dots along the posterior border, a more or less distinct black zigzag line across the outer fourth, and some dusky spots just above the middle of the wing. The hind wings are pure white.

There are two broods each year, the first brood of worms appearing for the most part during June, and giving out the moths in July, and the second brood occurring in the fall, passing the winter in the chrysalis state, and producing moths the following May.

Handpicking is the only remedy that it has been found necessary to adopt with this caterpillar whenever it becomes troublesome.

There are at least three natural enemies which serve to keep it in check. The largest of these is the Uni-banded Ichneumon-fly (*Ichneumon unifasciatorius*, Say), a large black fly, 0.60 inch long, and characterized by a white annulus about the middle of the antenna, a large white spot about the middle of the thorax, and a white band on the first joint of the abdomen.

This fly oviposits in the larva of the Smeared Dagger, but the latter never succumbs till after it has spun up and become a chrysalis, for I have always obtained the Ichneumon from the chrysalis. The other parasites are smaller and work differently. They each cause the larva of the Smeared Dagger to die when about full grown, and its contracted and hardened skin, which may often be seen during the winter, with the head attached (Fig. 30, *a*), fastened to the twigs of apple and wil-

[Fig. 30]

low trees, forms a snug little house where the parasite undergoes its transformations and through which it gnaws a round hole (Fig. 30, *b*), to escape the latter part of April. One of these flies (*Aleiodes Rileyi*, Cresson,) is described on page 382, of Volume II, of the Transactions of the American Entomological Society, and is of a uniform reddish-yellow color. The other is a black fly of about the same size, but belonging to an entirely different genus, *Polysphincta*. It has two prominent carinæ on the dorsum of the basal joint of the abdomen, and the legs, except the hind tarsi and last half of hind tibiæ are rufous. It is marked *bicarinata* in my MS., but I omit the description as I do not possess the female. The first of these parasites is in its turn preyed upon by a minute *Chalcis* fly of a steel-blue color with honey-yellow legs, which issues in great numbers through a very minute hole, from the dried caterpillar skins.

As I know of no description of *oblinita* in the English language, and as that of Guenée is rather summary, I subjoin the following:

Acronycta oblinita, Sm. and Abb.—*Imago*—Front wings oblong; apex more or less prolonged; posterior margin sometimes rounded, sometimes straight; color ash-gray, caused by numerous dark brown atoms more or less suffused on a white ground, from which the ordinary lines are barely discernible in the better marked individuals; a row of distinct black dots along posterior border; the ordinary spots represented by blurred marks or entirely obsolete; the undulate line across posterior fourth of wing distinct, and relieved inside by a pale coincident shade, with the teeth quite aciculate and with the psi-spot so characteristic of the genus, but rarely traceable; fringe narrow and generally entire. Hind wings pure white, with a faint row of dark spots around posterior border. Under side of both wings white with faint fulvous tint and faint irrorations; each wing showing the brown discal spot and the row of points at posterior border. Head and thorax speckled gray; abdomen whitish-gray; antennæ short, simple in both sexes, gray above and brown below; palpi small. Two specimens with the front wings very dark, showing the ordinary lines and spots conspicuously, and with the antennæ brown above as well as below. Average length, 0.75; expanse, 1.75 inches.

Described from numerous bred specimens.

Larva—Prevailing color black. Each joint with a transverse dorsal crimson-red band across the middle from stigmata to stigmata, and containing six warts, each furnishing 10 or 12 or more stiff yellow or fulvous bristles, and the two dorsal ones being farthest apart. A sub-dorsal longitudinal yellow line interrupted by this transverse band and at incisures, in such a manner that the black dorsum appears somewhat diamond-shaped on each joint. A broad, wavy, bright-yellow stigmatal line, containing a yellow bristle-bearing wart in middle of each joint. Lateral space occupied with different sized pale yellow spots, largest towards dorsum. Head chesnut-brown. Venter crimson-black, with bristle-bearing warts of same color. Stigmata oblong-oval and pale. Thoracic legs black; prolegs with black extremities. Such is the normal appearance of this larva, but it is very variable. In some the yellow seems to predominate over the black, and there is a more or less distinct dorsal line. In some this dorsal line forms a mere speck at the incisures of the middle joints. The transverse crimson band is often entirely obsolete, and the warts distinctly separated, while in others where this band is distinct, the warts frequently coalesce.

Pupa—Almost black, and shagreened with the exception of a smooth and polished rim, at posterior border of joints, which becomes reddish, especially ventrally, on the three joints immediately below wing-sheaths. Terminal joint horizontally compressed, squarely cut off, and furnished with a little brush of short evenly-shorn, stiff rufous bristles.

THE PYRAMIDAL GRAPE-VINE WORM.—*Amphipyra pyramidoides*, Guen.

(Lepidoptera, Amphipyridæ.)

Another worm, never hitherto mentioned as injurious to the Grape-vine, is often found resting upon it in the posture shown in

[Fig. 31.]

Figure 32, and may be at once distinguished from all others that are known to attack it, by having a pyramidal hump near the end of its body. This worm I have also found upon the Red Bud (*Cercis canadensis*), the Raspberry and the Poplar, but it is only as a vine-feeder that it can be considered injurious. It was more abundant in the summer of 1869 than it has been since. According to the experience of Mr. G. Pauls, of Eureka, it takes the Hartford, Israella and Iona first, and the Concord and North Carolina next, and devours the blossoms as well as the leaves. It is of the form shown in the figure and of a delicate green color, marked with pale yellow or cream-colored lines and spots, as there indicated. It is found on the vines during the month of May with us, and during the forepart of June descends to the surface of the ground, where it spins a loose cocoon of whitish silk, generally constructed between some fallen leaves. Within this cocoon it remains some time in the larva state, but eventually becomes a shiny mahogony-brown chrysalis from which emerges a moth (Fig. 31), with the front wings bark brown and glossy and marked with dark brown and pale grayish-brown as in the cut; and with the hind wings of a lustrous copper color,

[Fig. 32.]

from which character it may be called in popular language the American Copper Underwing. In Chicago, Illinois, this insect is single-brooded, for a poplar-feeding larva found the latter part of May, and which spun up on the 14th of June, did not produce the moth till the following April; but specimens obtained near St. Louis often produce the moth during July of the same year that they are found as worms. In this last case a second brood is doubtless produced the same year though it is barely possible that the moths winter over and do not deposit till spring; for they are characterized by having very flat bodies, and with their wings folded flatly on their backs they are often found hiding in narrow cracks and crevices where they seem to love to shelter.

There is an insect (*Amphipyra pyramidea*, Linn.) very common throughout the continent of Europe, on Elm, Poplar, Oak, and other trees, and known in England as the Copper Underwing, which our *pyramidoides*, as its name implies, so very closely resembles in all its stages, that it is difficult for one who has become acquainted with both insects in the field, to bring himself to believe that they are really distinct species. No one can behold the two moths and speculate on their great similarity, without feeling that such close resemblance between the insects of two continents is hard to account for on any other theory than that of community of descent; or without questioning whether there really are differences enough to make two species, when he reflects that far greater variations often occur in the particular species of a given continent! The most constant difference seems to occur in the larvæ which, though they agree in almost every other detail, differ in the European species having the pyramidal hump more strongly developed and capped with a red horn-like point which curves backwards, while in our species this point is more or less obsolete and not red.

REMEDIES.—This worm is easily kept in check by hand-picking, and though its moth is attracted by sweets, it has never been numerous enough in the past to warrant this mode of capturing it. We have no good description of this insect in the English language, so I subjoin one.

AMPHIPYRA PYRAMIDOIDES, Guen.—*Larva*, (Fig. 32.)—Length when full grown 1.20–1.30 inch. Smallest at joint 1, largest at joint 11 which rises pyramidally above the others. Color pale bluish-green inclining to whitish dorsally, and rather darker at each end than in the middle of body. A continuous narrow cream-colored medio-dorsal line extending from the head to extremity of anal shield; a subdorsal line of the same color or somewhat more yellow, wavy and broken into 4 or 5 unequal spots on each of joints 1–10, more or less distinct, ascending continuously on joint 11 to the summit of pyramid, descending in a curve and vanishing in the anal shield; a broader stigmatal line, bright sulphur-yellow, except where intercepted by stigmata where it is white, distinct on joints 1 and 2, less so on 3 and 4, and running straight to the extremity of anal shield. Looking downwards from the top of the pyramid, six lines seem to radiate from it in as many different directions. Besides these lines, each joint has about ten cream-colored piliferous spots, namely, 4 in dorsal space—the anterior ones nearest together—one in the middle of each joint in subdorsal space, and 2 smaller substigmatal ones. These spots are more or less obsolete on the thoracic and anal joints; they are arranged transversely on the former, and the hairs arising from them are so insignificant that they are scarcely visible. Stigmata white, with a black annalation. Head free, smaller than joint 1, concolorous with body. Venter darker green with cream-colored points. Legs of the same color, the thoracic with three brown, or black spots outside, the prolegs with purplish clingers. Described from two grape-feeding, two poplar-feeding specimens.

Pupa.—Highly polished mahogony-brown, rather short and thick, impunctate, and with two small short spines and several fine curled bristles at the extremity.

Imago.—*Front Wings,* with the costal margin more or less arched and the posterior margin more or less scalloped or dentate; general color brown, being variegated with a pale glossy gray, with more or less fulvous, glossy purple-brown and unpolished purple-black; the transverse anterior nearly obsolete or tolerably well defined, in strong zigzag, pale with a dark shade each side; reniform spot entirely obsolete, or well indicated and pale; orbicular small and illy defined, or large and forming a pale ring with the centre sometimes concolorous, sometimes lighter than median space, and with the basal side sometimes, not always, extended into a beak or point; transverse posterior well relieved inside but not outside, except at costa; it starts distinctly about the middle or a little outside the middle of costa, runs outwardly at right angles along costal nerve, either its own width or twice its width, thence obliquely outwards towards the middle of the wing, with a more or less conspicuous inward jog or curve in discoidal cell; thence across the wing in 4 undulations: in some specimens it makes an obtuse angle, so that the inner half runs parallel with the posterior margin, in others it runs almost straight across the wing, so as not to be parallel with the margin at any point; in some it traverses the wing so as to leave a full third, in others so as to leave only a fourth of the wing outside; subterminal line pale and broken, scarcely distinguishable, or well defined, especially at costa, where the apical space is pale and blends with it, or as brown as the rest of wing and relieves it; a series of 8 more or less distinct pale terminal dots, often relieved by an outer black shade, fringes concolorous: sometimes with a pale middle line often broken and appearing like a second series of dots; the posterior median space is the darkest, and the subterminal space the lightest portion of the wing, though the contrast is often very slight. In one dark specimen the sagittate spots and a longitudinal shade in the discoidal cell and another below the sub-median nerve—the two dividing the wing in three equal parts longitudinally—are very conspicuous from their being very dark and without gloss; in two specimens these marks are entirely obsolete; under surface smoky-gray, more or less suffused with fulvous, and with a dark shade below transverse posterior. *Hind wings* bright glossy cupreous, or with but a very faint tint of this color, and more or less distinctly grayish-brown along the costa to the third superior nerve and the upper posterior border; fringe scalloped, grayish-brown, with an inner paler hue; under surface more or less concolorous, with the lunule indicated and with a broad line, half black, half cupreous. *Thorax,* with the scales large and mixed fulvous and brown. *Abdomen,* with the sides dark, intercepted by the fulvous margins of joints; anal tuft more or less rufous. *Legs* with the tibiæ and tarsi alternately fulvous and brown. Expanse 1.65–1.90 inches.

Described from four bred and four captured specimens.

The differences between the European *pyramidea* and this species, as given by Guenée, are: First, In *pyramidea* the transverse posterior curves outward near the costa, so as to produce an inward sinus in the discoidal cell, while in *pyramidoides* it runs nearly straight and obliquely; Secondly, in *pyramidoides* this line is said to border a median space almost always darker than the rest of wing and absorbing the darker longitudinal lines, while the light lines are given as narrower than in *pyramidea,* and the subterminal more continued to costa, where it borders, or cuts, as Guenée has it, a light apical space. While the difference mentioned in the transverse posterior is tolerably constant in the eight specimens of *pyramidoides* in my possession, I have seen two in other collections where this line was almost a fac-simile of the same line in *pyramidea*; and the other characters, as will be seen from the above description are quite variable, sometimes approaching the typical *pyramidea* and sometimes the typical *pyramidoides.* The same variations doubtless occur in the European species, for if we can rely on Mr. Edward Newman's figure (British Moths, p. 457,) the median space is sometimes as much darker than the subterminal in their insect as it is said, by Guenée, to be in ours Upon critically examining two European specimens of *pyramidea* in the collection of my friend, Mr. A. Bolter, of Chicago, I find this shade very distinct on the posterior portion of the median space, but instead of closely bordering and relieving the transverse posterior it fades somewhat before reaching it. The transverse posterior crosses the wing nearer the middle than in our species, leaving, in one of the specimens, more than one-third of the wing outside. But the distinguishing features which struck me as less subject to variation than those mentioned by Guenée, are the somewhat more elongate wings and the broader, more distinct, subterminal line of *pyramidea.* I have little doubt, however, but that from a hundred specimens of each species at least one *pyramidea* and one *pyramidoides* could be found that were undistinguishable in themselves. The undersides of the two species agree entirely.

There is but one other described, N. A. *Amphipyra*, namely, the *A. inornata* of Grote—(*Pro Ent. Soc, Phil.*, III, p. 86,) which upon the very face of it, seems to be but a small variety of *pyramidoides*, as will be seen by comparing his description with that found above. The species was described from a single specimen belonging to Mr. Wm. Saunders, of London, Ont., who agrees with me in believing it to be but a variety of *pyramidoides*.

I have a unique in my cabinet which differs so remarkably in the front wings from *pyramidoides* that I feel constrained to briefly describe it, and yet in all other characters it so closely resembles that species that I should hesitate to do so, had I not bred it from the larva. It looks exactly as though something had been sprinkled uniformily over the front wings and had eaten the dark color away in spots and splashes, but the specimen is in reality perfect, with not a scale ruffled. It may be called the Spattered Copper Underwing:—

AMPHIPYRA CONSPERSA, N. Sp.—*Larva.*—Found full grown July 2nd, 1867 on Hazel. No pyramindal hump, and of a uniform emerald-green, the dorsal palpitations visible and the stigmata pale with a black annulation, but with no other markings either on the head, body or legs.

Imago—Like *pyramidoides* in every particular except that the brown of front wings is almost uniformily spattered over, more or less suffusely with pale grayish spots so that no regular marks appear. The costal marks are however tolerably distinct as in *pyramidoides* and by careful examination and comparison, traces of the more conspicuous marks of that species may be discerned.

Described from one ♀ bred July 31st.

THE GRAPE-ROOT BORER—*Ægeria polistiformis*, Harr.

(Lepidoptera, Ægeridæ.)

The most common root-borers of the Grape-vine in this State are those which I have termed Gigantic Root-borers, namely, the larvæ of two large beetles (*Prionus laticollis* and *P. imbricornis*) which were treated of in my previous Reports. The insect now under consideration is a moth and not a beetle and has for a number of years been known as THE Grape-root Borer. It bears a very close resem-

[Fig. 33.]

blance to the common Peach Borer, both in habit, and in the size and general appearance of the larva, but it is a somewhat larger insect and the moths differ materially.

It has usually been considered a Southern insect and certain it is that it is not as destructive in the vineyards of Missouri as the Gigantic borers. But I captured specimens of the moth and found the larva in St. Louis county last summer, and it has long been known to be destructive throughout Kentucky. It was also reported around Cincinnati in 1867, though there is no evidence that the insects attacking vine roots there were this species and not the Gigantic borers.

The larva can easily be distinguished from the Gigantic root-borers, by having 16 legs as in all normal Lepidopterous larvæ, namely, six true horny legs head near the and ten false or membranous legs, eight of which are in the middle and two at the end of the body. When full grown it measures from an inch to an inch and three-quarters, and it then forms a pod-like cocoon of a gummy sort of silk covered with little bits of wood-bark and dirt, within or adjacent to the injured root. Within this cocoon it becomes a chrysalis which, in due time, by aid of rows of minute teeth with which it is furnished, works its way out of the cocoon to the surface of the ground, and gives forth the moth. As with the Peach Borer, this insect requires a year to develop and is found in its different states of larva, chrysalis and moth, throughout the summer months, and it doubtless also passes the winter as a larva.

The moth looks very much like a wasp and especially like some belonging to the genus *Polistes*—whence its specific name—and the resemblance becomes still more striking when flying, for its flight is accompanied by a buzzing wasp-like noise. The sexes differ considerably though not as much as in the case of the Peach Borer. The colors are dark brown and tawny-orange, and the male is well represented at Figure 33, *a*, and the female at *b*, but as the description which was published seventeen years ago by Harris, and copied by Mr. Walsh in his Report, is brief and defective, I subjoin one which is more complete:—

ÆGERIA POLISTIFORMIS, Harris,—*Imago* ♀—*Head*, including the palpi, orange-tawny. Antennæ simple, blue-black; orange-tawny above at their extreme base and tip and below for their entire length. *Thorax* black; varied with orange-tawny and bright yellow on the lateral and posterior surface above, and below for its entire surface. *Abdomen* generally with the four basal joints black and the rest orange-tawny; sometimes almost entirely orange-tawny; sometimes almost entirely black; always with a narrow yellow ring at the tip of the second joint above and generally with another such ring at the tip of the fourth joint; venter mostly black with the tip of all the joints more or less edged with orange-tawny, and with a short lateral pencil of orange-tawny hairs springing from the tip of the penultimate joint below, and reaching a little beyond anus. Legs orange-tawny above, mostly black below but with a yellow patch at the origin of the middle spurs on the hind tibiæ. All the spurs and tarsi more or less tinged with yellow. Front wings brown-black with a more or less distinct clear space at base, longitudinally traversed by a nervure; hind wings hyaline, with the veins, the terminal edge and the fringe, brown-black. Length 0.66—0.85 inch; expanse 1.15—1.50.

The ♂ differs from the ♀ as follows:—1st. The antennæ are bipectinate four-fifths of the way to the tip, which is strongly clavate and, as in the ♀, bears a few hairs at its apex. The bipectinations are fully one-fourth as long as the head is wide, and, as well as the entire basal half of the antennæ are orange-tawny. 2nd. Both thorax and abdomen are darker, and in addition to the pair of short anal pencils below, there is a pair nearly twice as long above. 3rd. The short hyaline space straddling a black nervure at base is more distinct. Length 0.68 inch; expanse 1.10 inch.

Described from 1 ♂ 1 ♀ bred July 8th—16th, from grape roots, and others captured during August at Kirkwood, Mo. It is remarkable that although Dr. Harris chronicles in his correspondence with Dr. LeBaron, as a notable event, his having captured an *Ægeria* with pectinate antennæ in New England in 1850,* in 1851, when for the first time he described the moth of our Grape-

*Harris correspondence, p. 262.

root borer, he did not say a single word about the ♂ antennæ being bipectinate, if we are to judge from the account he gives in a Report made to the American Pomological Society in 1854 (p 10.) Either his ♂ specimens had lost their antennæ, or the pectinations were rubbed off, the former being the more likely occurrence. Certain it is that the males received by Dr. Harris once had pectinated antennæ, for though Mr. Glover, copying after Harris, likewise fails to mention this sexual character in his account published in the Patent Office Report for 1854 (p. 80), he nevertheless plainly figures the pectinations (Ibid, Pl. 6, lower right hand figure) and the specimens from which he made the figure were received from the very same person who furnished Dr. Harris with his specimens.

Unlike the Peach Borer which makes its abode quite near the surface, this borer lives exclusively under ground, and unlike the Gigantic root-borers which hollow out and bore up along the heart of the roots, it confines itself almost entirely to bark and sap-wood, and the effects of its work are consequently more fatal to the vine. Roots attacked by it, to use one of Mr. Walsh's expressions, look "as if a drunken carpenter had been diligently scooping away the sap-wood with a quarter-inch gouge." It must, however, sometimes hide under the bark of the roots, as Mr. H. J. Kron of Albemarle, North Carolina, in the Monthly Report of the Department of Agriculture for 1867, (p. 329), describes it as being shielded by the bark.

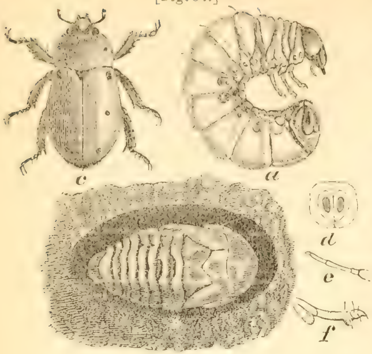
Remedies—It has been ascertained by observation and experiment that the Scuppernong grape-vine—which, according to Gray, is a cultivated variety of the Southern Fox Grape (*vitis vulpina*)—is never attacked by this borer, and consequently that other varieties grafted on to the Scuppernong share its immunity from attack. This is a very easy mode of preventing its ravages in the more Southern States where the Scuppernong flourishes; and if this borer should ever become very numerous with us, it may be deemed advisable to introduce that stock here. At present we have no other preventive than mounding, and the insect is so comparatively scarce that I have not yet had an opportunity of testing whether such mounding would work as well as it does with the Peach Borer. When it is once ascertained that the borers are at work on a vine, they may be destroyed by clearing away the earth and applying hot water to the roots.

THE SPOTTED PELIDNOTA—*Pelidnota punctata*, Linn.

(Coleoptera, Scarabæidæ.)

This is the largest and most conspicuous beetle that attacks the foliage of the Grape-vine, and in the beetle state it seems to subsist entirely on the leaves of this plant, and of the closely allied Virginia Creeper. Though some years it becomes so abundant as to badly riddle the foliage of our vineyards, yet such instan-

[Fig. 34.]



ces are exceptional; and it usually occurs in such small numbers, and is so large and clumsy, that it can not be considered a very redoubtable enemy.

Its larva has, for a number of years been known to feed on the decaying roots of different trees, but was first described by me last September.* It is a large clumsy grub (Fig. 34, *a*) bearing a close resemblance to the common White Grub of our meadows, and it differs from that species principally in being less wrinkled, and in having the chitinous covering (or skin, so-called) more polished and of a pure white color, and in the distinct heart-shaped swelling above the anus (Fig. 34, *d*). Towards the latter part of June I have found this larva in abundance, in company with the pupa (Fig. 34, *b*), in rotten stumps and roots of the Pear. In preparing for the pupa state, the larva forms a rather unsubstantial cocoon of its own excrement, mixed with the surrounding wood. The pupa state lasts but from eight to ten days, and the beetle (Fig. 34, *c*) is found on our vines during the months of July, August and September. It is not yet known how long a time is required for the development of the larva, but from analogy we may infer that the insect lives in that state upwards of three years.

This beetle was named about a century ago by Linnæus who met with a specimen in the magnificent collection of shells and insects belonging to Queen Louise Ulrica of Sweden. It occurs throughout the States and Upper Canada, and is even met with in the West Indies. It flies and feeds by day, and is most abundant during the months of July and August. The wing-covers are of a slightly metallic clay-yellow color, with three distinct black spots on each, and the wings themselves are dark-brown inclining to black: the thorax is usually a little darker than the wing-covers, with one spot each side: the abdomen beneath, and legs, are of a bronzed-green. It is easily kept in check by hand-picking.

PELIDNOTA PUNCTATA, Linn.—*Larva* (Fig. 34, *a*)—Length 2 inches; clumsy, moving on the side. *Head*, bright chestnut-brown, smooth, rounded, with a short, impressed, longitudinal line on the top, and three shallow impressions in front; epistoma trapezoidal and darker; labrum rough, irregularly punctate, and beset on the margin with a few stiff rufous hairs; antennæ (Fig. 34, *e*) as long as epistoma and labrum together, 4-jointed exclusive of bulbus or tubercle in which they are inserted; joints cylindrical, proportioned in length as 2, 6, 4, 1, the terminal joint being often a mere bud; mandibles strong and black, with three denticulations at tip, and a very slight tooth at inner basal portion; maxillæ brown and subcylindrical on outside, angulated on inside, bearing two lobes, each terminating in an inwardly-curved corneous tooth, and each furnished

* See American Entomologist and Botanist, Vol. I, p. 295.

on their inner narrow edge with stiff bristles, the outside one arising close by base of palpus, the inside one extending lower down, and recalling by its form, the terminal joint of the front leg of a scorpion; maxillary palpi 4-jointed, joints cylindrical, short, very gradually longer and longer from 1 to 4, the terminal joint more pointed and narrower than the others; labium quadrangular, labial palpi 2-jointed, the palpigerous piece strongly beset with bristles. *Body*, smooth with but a few wrinkles at thorax; polished translucent white, with faint bluish marblings on all but thoracic joints which are slightly narrower than the rest; a narrow vascular dorsal line, and a very slight yellowish horny plate in a depression on joint 1; a very slight pubescence observable, and a transverse tergal row of sparse but tolerably long hairs on posterior part of each joint; more dense and conspicuous hairs on lower sides of anal joint, which joint is short, cut off squarely, with a heart-shaped swelling [Fig. 34, *d*) sunk into a circular depression, each lobe of the heart with a darker oval corneous elevation; spiracles sub-elliptical, dark chestnut-brown, placed on a prominent swelling, the lateral openings *all* facing the head, the 1st on joint 1, the rest on joints 4, 5, 6, 7, 8, 9, 10 and 11, gradually becoming smaller and smaller from first to last. *Legs* (Fig. 34, *f*) horny, light-brown and covered sparsely with hairs; coxæ long and stout, with a rounded swelling at lower anterior edge; femora cylindrical, sometimes, distinctly, at others indistinctly, separated from tibiæ, sometimes prolonged into a thorn below, with a distinct carina along the inside, at others not; tibiæ cylindrical, incrassated anteriorly, especially below; tarsi cylindrical and terminating in a distinct claw.

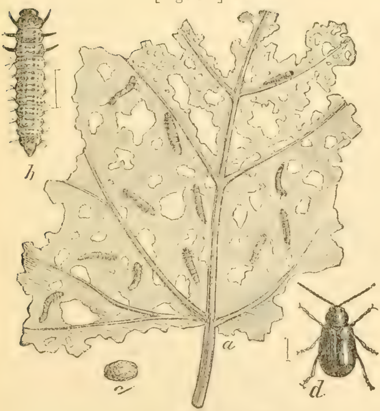
Pupa (Fig. 34, *b*) of the form of *Lachnosterna.*

Described from 12 living specimens.

THE GRAPE VINE FLEA-BEETLE—*Haltica chalybea*, Illiger.

(Coleoptera, Chrysomelidæ.)

[Fig. 35.]



Is there a grape-grower in the State of Missouri who does not know, to his sorrow, what the Grape-vine Flea-beetle is? Hardly one! And yet how few ever connect it with its disgusting little shiny brown larvæ, which generally prove still more injurious than the beetle, by riddling the leaves in the middle of the summer.

The Grape-vine Flea-beetle (Fig. 35, *d*) often goes by the cognomon of "Steel-blue Beetle," and is even dubbed "Thrips" by some vineyardists. The latter term, however, is entirely inapplicable.* The former name is not sufficiently charac-

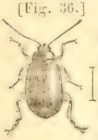
* The term *Thrips* is confined to an anomalous group of insects—mostly cannibal, but exceptionally vegetable feeding—of which Halliday made a separate Order (*Thysanoptera*), but which are to-day included in the *Homoptera*, or Whole-winged Bugs, by most authors, though they seem to have close affinities to the *Orthoptera*, and to the *Pseudoneuroptera.*

teristic, because the color varies from steel-blue to metallic-green and purple, and because there are many other flea beetles to which it would equally apply.

The Grape-vine Flea-beetle is found in all parts of the United States and in the Canadas, and it habitually feeds on the Alder (*Alnus serrulata*), as well as upon the wild and cultivated Grape-vine. Its depredations seem first to have been noticed in 1831, by Judge Darling, of Connecticut, and in 1834 Mr. David Thomas, of New York, published an account of it in the 26th volume of Silliman's *American Journal of Science*. Its transformations were, however, unknown till some time after Dr. Harris wrote his excellent work on Injurious Insects, and the figure of the larva was first published by myself last fall.

The beetles hibernate in a torpid state under any shelter which is afforded them in the vineyard, such as the loose bark and crevices of stakes, etc., etc., and they are roused to activity quite early in the spring. The greatest damage is done by them at this early season, for they often bore into and scoop out the unopened buds, and thus blight the grape-grower's bright expectations. As the leaves expand, the little jumping rascals feed on the leaves, and soon pair and deposit their small orange eggs in clusters, very much as in the case of the Colorado Potato-beetle. These eggs soon hatch into dark-colored larvæ, which may be found of all sizes during the latter part of May and early part of June. They are generally found on the upper surface of the leaf, which they so riddle and devour as to give it the appearance represented at Figure 35, *a*. When very numerous they devour all but the very largest leaf-ribs, and I have seen the wild vines throughout whole strips of country rendered most unsightly by the utter denudation which these insects had wrought. The larvæ feed for nearly a month, and when full grown present the appearance of Figure 35, *b*, the hair line at the side showing the natural size. They then descend from the vine and bury themselves a short distance in the earth, where, after each forming a little earthen cell (Fig. 35, *c*), they change to pupæ of a deep dull yellow color, and in about three weeks more issue as beetles. These beetles leave the ground from the middle of June to the middle of July, and, so far as I am aware, do not breed again till the following spring—there being but one brood each year. They subsist on the leaves during the fall, but the damage they inflict is trifling compared to that which they cause in spring.

[Fig. 36.]



Like all other Flea-beetles, this species has very stout, swollen hind thighs, which, though hidden in Figure 35, *d*, are well represented in the accompanying cut (Fig. 36). By means of these strong thighs they are enabled to jump about very energetically, and are consequently very difficult to manage during the summer months. In the winter time, however, they can be destroyed in great numbers while hidden in a torpid state in their retreats, for Dr. E. S. Hull, of Alton, Illinois, tells us* that they were once so numerous in a small vineyard of his that in the spring of 1867 he burnt them out by surrounding them with fire, and letting the fire run through the dry grass in the vineyard. "It was a rough remedy, but as his crop was destroyed, he let the beetles follow suit." Clean culture and general cleanliness in a vineyard will, to a great extent, prevent this insect's increase. Especially should the stakes be clean and free from old bark.

The larvæ can be more easily destroyed by an application of dry lime, used with a common sand-blower or bellows. This has been found to be more effectual than either lye or soap-suds, and is withal the safest, as lye, if used too strong, will injure the leaves.

This insect, like so many others, will one year swarm prodigiously, and then again be scarcely noticed; and such changes in its numbers depend mainly on conditions of the weather, as no parasite is known to attack it. In the spring of 1868, though they were at first out in full force, yet after some subsequent severe and cold weather, they had mostly disappeared. They are apt to be most troublesome where Alder abounds in the woods.

HALTICA CHALYBEA, Illig.—*Full-grown Larva.*—Length, 0.35 inch. Head polished black. Body livid-brown above, paler beneath; subcylindrical, the joints bulging, especially at sides, and each divided superiorly into two transverse folds; on each fold a row of six shiny-black elevated spots, the dorsal ones larger than the others, and often (especially the posterior two) confluent, or divided only by a very narrow dorsal line; each spot giving rise to a single short stiff hair; one such substigmatal black spot placed in middle of joint, and more elongated than the rest, being apparently composed of two confluent ones, as it gives rise to two hairs. Three ventral spots, one anteriorly, which is large, transversely-elongate, central, and without hairs; and two posteriorly (one each side) which are small and piliferous. Six black thoracic legs, and one anal orange proleg.

Pupa.—Length, 0.14 inch. Of the normal Chrysomelid form. Deep dull yellow, and covered more or less above with short black bristles arranged in a transverse row across each joint, and each arising from a slight elevation: two stouter anal bristles or thorns. Eyes brown. Tips of jaws brown.

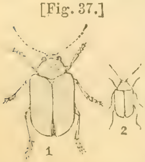
Described from numerous living specimens.

THE GRAPE-VINE COLASPIS—*Colaspis flavida*, Say.

(Coleoptera, Chrysomelidæ.)

There is a little clay-yellow beetle (Fig. 37, magnified, natural size), which does great injury to the Grape-vine by riddling the leaves. It is more or less abundant with us every year, but judging from recorded accounts is still more injurious in the Eastern States, and especially in New York. In the *Country Gentleman* for August 30th, 1866, occurs the following account of it by Dr. Fitch, in answer to a correspondent who wrote that they were destroying grape-vines by the wholesale:

[Fig. 37.]



* Proc. Alton Hort. Soc. for May, 1867.

"The rascals alluded to are a beetle of the Chrysomela family, and are the Brown Colaspis,* *Colaspis brunnea*, Fab. It is an oval, drab-colored beetle, nearly twice as long as broad, and nearly two-tenths of an inch in length, having the outer edge of his wing covers black, and also the under side of its body and the tip of its antennæ. It is rather a common insect throughout the United States, appearing in the latter part of June, each year, and continuing through the month of July. I have frequently gathered it from the wild grape-vine, the Cinquefoil or Potentilla, and some other plants, but have never known it to invade the cultivated grape until this year.

It has this season been the worst enemy that has attacked the vine in my neighborhood—riddling the leaves with small round holes, interspersed with large irregular ones—and I hear of it in several other parts of the country. * * *

Wherever the Leaf-folder (Fig.24) abounds, this beetle will almost invariably be found in conjunction with it in the fold of the leaf. On finding it so invariably in this fold, I at first supposed that it merely took advantage of the position for shelter, little suspecting that it would feed upon the worm, since the family to which it belongs is essentially herbivorous, and the Leaf folder is so very active; but from having found numbers of the shrunken and half-dead worms, I was led to conjecture that it does actually prey upon them; just as many true bugs (*Hemiptera*) though living naturally on the juices of plants, will still appropriate and relish those of certain caterpillars. Thus may one great pest serve to check another!

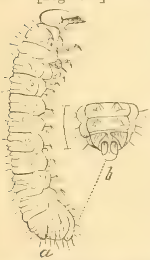
Of the natural history of this beetle nothing has hitherto been known. As the beetle was often found upon and greedily devours the leaves of the Strawberry, and as a white worm was known to injure the roots of that plant, I inferred several years ago (Prairie Farmer Annual 1868, p. 56), that this worm was the larva of the Colaspis. From the facts, however, that the larva of the European *Colaspis barbara* was described as a hexapod, blackish, glabrous grub

* Dr. Fitch referred this insect to *brunnea*, Fabr., and Mr. Walsh (*Practical Entomologist*, II, p. 68) criticised his course, and referred the species to *flavida*, Say. I adopt Say's name simply because it best indicates the general appearance of the insect, and not because I think Mr. Walsh was right in his strictures. I have kindly been allowed to examine Dr. Fitch's specimens; have examined specimens in other large Eastern collections, and those in the Walsh collection, and am convinced that the difficulty between the above two authors arises from the confounding of varieties with species. It is here, as in almost every other genus and Family, the closet systematist divides up and arranges with insufficient knowledge of the variation which species are subject to, and this was especially the case in years gone by, when every little colorational difference was generally supposed to be immutable. The naturalist, therefore, who studies insects for other and more laudable purposes than the mere naming and classifying of them, though fully aware of the importance and necessity of good and clear nomenclature, may well despair of bringing order out of the confusion which often exists, and which the miserably short and incomplete descriptions of older authors have had much to do in causing. The economist can spend his time more profitably, and so long as he always adds the authority to the name he uses, there will be no danger of causing more confusion, and he can coolly disregard the interminable disputes between different authors as to the proper technical name by which an insect should be known. In the present case, I simply give it as my opinion that *brunnea*, Fabr., *suilla*, Fabr., and *flavida*, Say, are all varieties of one species, because specimens according with each are found in the same vineyard, and because Say himself gives a variation in *flavida*, which differs much more from his description than does either *brunnea* or *suilla*. Mr. Walsh gives the antenna of *flavida* as having the last joint or two, and the tip of the last joint but four, brown-black, but there is variation here, and the dark color on the last joint but four is often obsolete. The exterior edges of the elytra are either concolorous or of all shades of brown to black, and the same may be said of the sutural edges. There is also a somewhat larger form, which must certainly be referred to the same species, which has the punctures so much less profound as to give it a much smoother and more highly polished appearance.

living unprotected upon the leaves of lucern and clover,* and that such was the character of the larvæ of most other insects belonging to the great *Chrysomela* family, I had little confidence that my reference would prove the correct one. Yet it so proved to be, and I have bred the beetle from larvæ infesting strawberry roots that were kindly sent to me by Mr. J. B. Miller, of Anna, Ills. Just as in the European Turnip Flea-beetle (*Phyllotreta nemorum*), the larva mines the leaves above ground, while in our very closely allied Striped Flea-beetle (*Phyllotreta striolata*, Illig.), it feeds upon the roots below ground; so there seems to be the same difference of habit in the genus *Colaspis*. In this last case the difference is not only of habit, but the structure is modified in accordance with the habit, and we have in our Grave-vine Colaspis a Chrysomelid larva bearing a very close resemblance to that of a Lamellicorn.

It is indeed a most singular larva, and differs from all others with which I am acquainted, in having on the underside of the legless joints a pair of curious fleshy projections reminding one of legs, and terminating in about two stiff hairs (Fig. 38, *a*). The office of these appendages it is difficult to conjecture, for they seem to impede rather than aid in locomotion on a flat surface, though, when the habits of the larva are more critically studied, these appendages will doubtless be found to subserve some useful purpose. The color of this larva is yellowish or grayish-white with a gamboge-yellow head. The pupa is formed in the ground and exhibits no unusual characters.

[Fig. 38.]



We are now only treating of this insect as a Grape-vine pest; but it is difficult to say whether the Crown-borer (Fig. 14) or this root-eater is the most injurious to the Strawberry. The work of the two is essentially different, the white Crown-borer confining itself to the crown, and its more dingy ally devouring the fibrous roots and working into the more woody parts from the outside. At this work several of them may frequently be seen with their heads stuck into different parts of one root. They may be found upon the roots all through the fall, winter and spring months, and do not begin to change to pupæ in this latitude till about the month of June, the beetles appearing during that month and continuing to issue from the ground till towards fall. As soon as they issue from the ground they commence to feed upon the tender leaves, and in a measure injure the plants by riddling them with holes. After feeding for a while on strawberry leaves, and depositing their eggs, they spread on to other plants and are generally found most numerous in the vineyard during the latter part of July and during August, where, according to Mr. Miller, they show a partiality for the leaves of the Delaware.

*Notice sur les Devastations de la Larve du *Colaspis barbara*, par M. Leon Dufour—Annales de la Soc. Ent. de France, 1836, pp. 371—372.

Such, in brief, is the history of this common beetle, as far as I have been able to trace it. It doubtless has natural enemies, and ants are so fond of the helpless pupæ that the Colaspis never occurs on the roots where they abound. The evil effects of its work are more apparent on young and newly set plants than on older ones, and the only way to prevent the ravages of the worm, which we yet know of, is to so protect newly set plants that the beetles will not get access to them. I have had no opportunity to make experiments, but it may turn out that some application to the ground or to the plant, such as ashes, soot, lime, or salt, will ward off the perfect beetle, and I shall be glad to hear reports from those who are troubled with the pest. The same remedies used in killing the Colorado Potato-beetle would also kill this species.

COLASPIS FLAVIDA, Say—*Larva*, (Fig. 38)—Color dingy yellowish; uniformly covered with sparse stiff yellowish hairs. Having the general appearance of a Lamellicorn larva. Slightly arched but capable of stretching out tolerably straight. Narrowest in middle of body, the thoracic and anal joints being slightly swollen. The joints with about three dorsal wrinkles to each. Head honey-yellow, rounded, flattened in front; epistoma and labrum of same color; jaws darker. Legs pale, setous, and terminating in a brown claw. Spiracles scarcely perceptible, the first sub-ventral between joints 1 and 2, the others placed on a lateral series of swellings commencing with joint 4. Joints 4-11 inclusive, each with a pair of soft ventral leg-like appendages, ending in two or more stiff hairs. Anal joint somewhat horny below (Fig. 38, *b*) but with no trace of prolegs. Length 0.25—0.30 inch. Described from two rather poor alcoholic specimens.

THE GRAPE-LEAF GALL-LOUSE—*Phylloxera vitifoliæ*, Fitch.

(Homoptera, Aphidæ.)

Here we have an insect, the life-history of which is as interesting to the entomologist as its devastations are alarming to the grape-grower. I have given it considerable attention the past summer, and though it is a difficult task to present definite and satisfactory information from the multitude of facts obtained, yet I shall endeavor to give a comprehensive account of this little louse, so far as my present knowledge of it will permit. In doing so I am made painfully aware that there is much room left for further observations, and he who will patiently and persistently devote his time for a few years to its study, and will with candor and accuracy give to the world the re-

[Fig. 39.]

sults, will doubtless be rewarded by new and important discoveries, and will render valuable service to the cause of science and of economic entomology.

The first reference to this insect was briefly made by Dr. Fitch, of New York, in the year 1856,** and he subsequently described it in a very insufficient manner, under the name of *Pemphigus vitifoliæ*;* but though the specific name must be retained, the insect was wrongly referred to the genus *Pemphigus*, as we shall presently see. Ten years afterwards this louse was again referred to by myself in the *Prairie Farmer* for August 3, 1866, and during the fall of the same year articles were written upon it by Dr. Shimer,† and by my late associate, Mr. Walsh‡—the former claiming that it was a true Plant-louse (*Aphis* family), and the latter that it was a Bark-louse (*Coccus* family). In this Dr. Shimer was evidently right, and Mr. Walsh wrong. In January, 1867, Dr. Shimer proposed for this insect a new family (DACTYLOSPHÆRIDÆ),§ which, in my opinion, cannot stand.

But not to weary the general reader with purely scientific questions, I shall give the reasons for my opinion on this point, together with some other details, in smaller type at the close.

This louse was subsequently treated of by Mr. Walsh in his report as Acting State Entomologist of Illinois (pp. 21-24), where he still felt inclined to place it with the Bark-lice, though I have good reason to believe that he afterwards changed his mind. During all this time a serious disease of the roots of the Grape-vine began to attract attention in the south of France, and it finally caused such alarm that the Minister of Agriculture and Commerce in France offered a prize of 20,000 francs for the discovery of an efficacious and practical remedy.

A special commission was also appointed to draw up a programme of conditions, examine memoirs submitted to it, settle the experiments to be made, collect evidence from local commissions, and if they saw reason for so doing, to award the prize offered by government. The commission consisted of M. Dumas, M. Milne Edwards and M. Duchartre, of the Paris Academy of Sciences; M. Gervais, M. Planchon, M. Henri Mares and M. Louis Vialla, of Montpellier; the Comte de Vergue, of Gironde; M. Bedel, of Vaucluse, and three members of the Ministry of Agriculture.

The disease is known as *pourridie*, or rotting. It is in the form of little cankerous spots, which cut off the supply of nourishment and cause the roots to rot, and these spots were ascertained by MM. Planchon and Lichtenstein, of Montpellier, to be caused by a louse (*Phylloxera vastatrix*, Planchon,) which bears a close resem-

** N. Y. Rep. I, p. 158.

* Rep. 3, § 117.

† *Prairie Farmer*, Nov. 3 and Dec. 8, 1866.

‡ *Pract. Ent.*, Vol. I, p. 111; Vol. II, p. 19; and Proc. Ent. Soc., Phil., VI, pp. 283–4, notes.

§ Proc. Acad. Nat. Sci., Phil., Jan. 1867.

blance to our gall-insect. This is not all, for a leaf-gall absolutely identical with ours also occurs there, and the identity of the gall-inhabiting with the root-inhabiting insect was demonstrated by "J. O. W.," in the *Gardener's Chronicle*, of England, for January 30, 1869, and M. J. Lichtenstein even contended that their European species was identical with ours, and imported from this country, in which opinion he was supported by A. Combe-Dalmas.*

Of course these views expressed in Europe gave increased interest to our own gall-louse, and I determined to make every effort to decide the question of identity, together with some other questions which presented themselves. To this end I opened correspondence with M. V. Signoret and M. J. Lichtenstein, who were making experiments in France while I was doing the same here. But the blighting effects of the war have not only entailed untold misery and woe to millions in France, but have either paralyzed or effectually balked scientific investigation within her borders, so that at last accounts M. Lichtenstein was in Spain, and M. Signoret shut up in Paris.† I was, however, fortunate enough to receive from the latter gentleman, a few days previous to the investment of Paris, a letter stating that upon examination of specimens of our gall-lice, which I had expressed to him, he was convinced of their identity with the European species. This was indeed satisfactory, and coupled with the fact that I have discovered that our gall-insect likewise attacks the roots of our vines in precisely the same manner as does the European species, and that the winged specimens found in this country by Dr. Shimer agree in having the characteristic dusky band around the middle of the thorax described in the winged female of Europe, it leaves no doubt in my mind that the insects of the two continents are really identical.

As already stated, the war put a stop to investigations in France, and we do not know that any effectual remedy was discovered, or that the premium was disposed of. Carbolic acid, and two other substances, namely, sulphuret of lime dissolved in water, and an empyreumatical oil, known among veterinary surgeons by the name of "oil of cade," dissolved in water, were found to be the best specifics; but neither of them have been tried on a sufficiently extensive scale, and I have little faith in any medicinal remedy.

The two parties who have written most upon the disease, namely, Mr. Signoret and M. Lichtenstein, took entirely opposite grounds as to its cause. The former claimed that it had a botanical rather than an entomological cause, that it was principally due to drouth, bad culture and poor soil, and that the *Phylloxera* was therefore incidental; and acting upon this view, suggested that water, with manure

* *Insectologie Agricole,* 1869, p. 189.

† Since the above was written, I have heard from M. Signoret through M. Lichtenstein. Nothing daunted by the siege, the former carried on his studies of this little louse, and wrote by balloon, that though he himself was reduced to cats, dogs and horse-flesh, the *Phylloxera*, which he had in boxes, kept well and in good health. No doubt our enthusiastic friend finds much solace in thus pursuing knowledge under difficulties.

and good cultivation, would do away with it; while the latter maintained that the *Phylloxera* was the sole cause of the trouble. There are, doubtless, certain conditions of soil which will prove favorable to the increase of the louse, and it may also be influenced by the seasons and by good or poor cultivation; but that this insect should be found only on such roots as are already diseased is highly improbable, and there can be no reasonable doubt that M. Lichtenstein is right in attributing the disease directly to the *Phylloxera*. The appearance of mites is the almost inevitable consequence of diseased and rotting vegetation, but Plant-lice cannot live on such vegetation, and invariably leave it as soon as they have, by their punctures, reduced the healthy tissues to such a state. Moreover, the history of our louse, which I shall now proceed to give, corroborates M. Lichtenstein's views.

In Missouri this insect has proved very injurious to the Clinton vine for several years past—at least as far back as 1864, when the foliage of the Clinton was reported, in the proceedings of our State Horticultural Society, as "very bad"—and Mr. Geo. Husmann informed me that in 1869, it actually defoliated three-fourths of an acre of Clintons and Taylors on bottom land at Bluffton, though it did not appear to do much injury on the hills. It was quite bad around Kirkwood the present year, and, judging from reports, of correspondents and from my own observations, it was more than usually abundant in most of the Eastern States.

In this latitude the first galls are noticed by about the middle of May, and by the middle of June they begin to be quite common. It occurs most abundantly on the Clinton and Taylor, but is also found on the wild Frost Grape(*V. cordifolia*), and such other cultivated varieties of it as Golden Clinton and Huntington; also on the Delaware, and early in the year I even found a few large galls on the Concord. According to Dr. Morse it also occurs on the Iona, which is a variety of the Northern Fox Grape (*V. labrusca*). The galls vary somewhat in appearance, according to the vine upon which they occur, those I have noticed on the wild Frost Grape being more hirsute than those on the cultivated Clinton, and these again rougher than on the Taylor.

The few individuals which start the race early in the year station themselves upon the upper side of the leaves, and by constant suction and irritation soon cause the leaf to swell irregularly on the opposite side, while the upper part of the leaf gradually becomes fuzzy and closes, so that the louse at last sinks from view, and is snugly settled in her gall. Here she commences depositing, her bulk increasing during pregnancy. Eventually she grows to be very plump and swollen, acquires a deep yellow or orange tint, and crowds the space within the gall with her small yellow eggs, numbering from fifty to four or five hundred, according to the size of the gall. The young lice are pale yellow, and appear as at Figure 40, *d*, *e*. As soon as they are hatched they escape from the gall through the orifice on the upper surface of the leaf, which was never entirely closed; and, taking up their abode on the young and tender leaves, in their turn form galls. The mother-louse, after completing her deposit, dies, and the gall which she occupied dries up. There are several generations during the year, and this process goes on as long as the vines put forth fresh leaves. As the galls multiply and the growth of the vine becomes less vigorous, the young lice sometimes so completely cover the upper surface of the newly expanded leaves as not to leave room for them all to form galls. In this event the leaf soon perishes, and the lice perish with it. When two or more lice are stationed closely together they often form but one gall, which accounts for the presence of the several females that are sometimes observed in a single gall. Those leaves which have been badly attacked turn brown or black, and sooner or later fall to the ground, so that the vine may become entirely denuded.

By August the insects generally become so prodigiously multiplied that they often settle on the tendrils, leaf-stalks, and tender branches, where they form excrescences and gall-like growths, differing only from those on the leaves in such manner as one would naturally expect from the difference in the plant tissues. By this time the many natural enemies of the lice begin to play sad havoc with them; and after the vine has finished its growth, the young lice, finding no more succulent and suitable leaves, begin to wander and to seek the roots, so that by the end of September the galls are deserted, and those few remaining on the vines generally become mildewy, and finally turn brown and dry up. Upon the roots the lice attach themselves singly, or in little groups, and cause by their punctures little swellings and knots, which eventually become rotten. Where vines have been badly affected with the gall, it is difficult to find a perfectly healthy fibrous root. Strange enough, these lice not only change their residence as winter approaches, from the leaf above ground to the root below ground, just like the Moor, who, having passed the summer on his roof, gets into his house in the winter; but, Proteus-like, they change their appearance in shedding their skins, and at the present writing (Nov. 6th) have all become tubercled, as represented at Figure 40, *g*.

No doubt the insect passes the winter on the roots in this tubercled state, but whether in the spring these tubercled individuals produce winged males and females, which rise in the air, pair, and by depositing eggs give birth to the apterous females which found the gall-producing colonies; or whether, as spring opens, they lay eggs on the roots, and the young hatching from these eggs crawl up on to the leaves and found those gall-producing colonies, are questions yet to be settled in the life-history of our Grape leaf-louse. The former hypothesis is, however, by far the most probable, for analogy would lead us to infer that winged males and females must be developed at some time during its annual course, and winged males are so rare in the galls that I have never been able to find them, though I have opened thousands upon thousands of the galls during the summer and fall months. Dr. Shimer, indeed, is the only fortunate individual who has found the winged insect in the galls, and, as he himself tells us, he only succeeded in finding four specimens in the fall of the year, after cutting open ten thousand galls; and he has really given us no proof that his winged specimens were really males, and not females. Let us hope, however, that by pointing out the gaps in the biological history of this insect, attention will be drawn to them, so that they may be the more readily filled.

These discoveries lead us to some most important practical considerations. It now becomes evident that this insect can be transported from one place to another on the roots, either upon transplanted vines or in earth containing fibrous roots. Doubtless it was by some such mode as this that the insect was introduced into France from this country. It may be in this manner likewise that it has in part spread from one portion of our country to another, though as it is found indigenously on the wild Frost Grape, the greater probabilities are that it exists wherever this wild grape is found, and has gradually spread from it on to the cultivated varieties. These probabilities are strengthened by the fact that new grape wood is always rooted in the spring, when the lice, according to my views, are leaving the roots. But the important fact remains, that the insect winters on the roots, and that to exterminate it from a vineyard we have but to root up and destroy, late in the fall, such vines as were affected with the galls. From the poor success that has attended the experiments made abroad to destroy the lice on the roots, and from the fact that it is so difficult to reach them, I have little hope that any other remedy will be found than that of extermination by the means indicated, or by plucking and destroying the gall-infested leaves as fast as they appear in the spring.

Another very important practical lesson may be derived from the facts here mentioned, namely, that no variety of the Frost Grape (*V. cordifolia*) should be cultivated and encouraged where those of the Fox Grape (*V. labrusca*) or of the Summer Grape (*V. æstivalis*) are known to be as good. Some of our best grape-growers, especially in the Mississippi Valley, already discard the Clinton and its nearest relatives as worthless, and, considering its liability to this disease, we heartily commend their conduct.

At the 15th annual meeting of the Illinois State Horticultural Society, at Galesburg, the Clinton was highly recommended by Mr. D. B. Wier, of Lacon, Ills., principally for its vinous and medicinal qualities; but in this recommendation he did not meet with much support except from Dr. Hull the State Horticulturist, who also, in the course of his remarks sustained Mr. Wier in his recommendation of the Clinton, though in our own State Horticultural Report for 1864

(p. 66.) he is reported as being much inclined to discard it, his objection being that it is "troubled by the apple-worm"—by which is doubtless intended, the Grape-berry Moth.

There is some difference of opinion among botanists and experienced grape-growers as to the number of indigenous species of the Grape-vine, and as to the true character of some of the cultivated varieties. Some botanists are inclined to the opinion that we have but two, or even but one, species; and certain it is that the fertile character of the hybrids would lead to such an opinion, if infertility of hybrids is to be taken as a test of specific character. But it is more generally accepted that we have four distinct species (*V. labrusca*, *æstivalis*, *cordifolia* and *vulpina*) and this view is held by most western men,* and is perhaps warranted when we reflect that the very term species is but arbitrary, and that fertility of hybrids is not valued so much as an indication of specific identity among plants and some of the lower animals, as it is among more highly organized beings.

As already stated, our Grape leaf-louse is now principally confined to varieties of the Frost Grape;† but as it has been found in limited numbers on Iona and Concord, which are considered as varieties of the Northern Fox, and on the Delaware, which is considered either as a Summer Grape or as a hybrid between the Summer and the Northern Fox, I fear it may yet spread and become injurious to these species. Morever, now that we know that our insect is identical with that of Europe, there is also great danger that it will attack all hybrids with the European *Vinifera*, some of which, as the "Goethe," now promise well. Thus the reasons for discarding the Clinton and other Frost grapes become multiplied, for their cultivation may endanger the whole grape-growing interest of the country. On entomological grounds, I say emphatically to western men, do not plant any more Clintons, and get rid of those you now have as quickly as possible.

At the recent meeting of our State Horticultural Society at St. Joseph, some little discussion followed a paper which I read on this gall-louse and I was pleased to find that Dr. C. W. Spaulding, well known as a successful and experienced grape-grower, together with many other members, fully concurred in the advice here given. He had examined many of his vines, after his attention had been called to the matter, and found that the lice were found principally on the roots of old vines, and not on those of young ones. At this meeting it was almost unanimously agreed that the Clinton was comparatively worthless and should be done away with, but a few of the more

* See Husmann, "Grapes and Wine"; Flagg, *Hearth and Home*, Sept. 3, 1870; Spaulding, Lecture delivered at the Illinois State Fair, 1870.

† Though Gray considers the Clinton a variety of the *Æstivalis*, it is more generally considered as belonging to *Cordifolia*, which its great liability to the gall-louse would indicate.

conservative members, hesitated about discarding it for fear that such action would bring about the very result which it was intended to avoid, *i. e.*, the spread of the insect on to other and more valuable varieties. In other words they feared that by taking away the Clinton, the lice which now prefer this variety and flourish and multiply upon it, would be forced to attack other varieties. They looked upon the Clinton, as a protector to the better kinds, by drawing the lice away from them, arguing, to parady the words of Shakespeare, that

"'Tis better far, to bear those ills we have
Than fly to others that we know not of."

Now while I admire the cautious spirit manifested in such an argument and admit that it seems plausible, I cannot believe there is any logic in it. The argument presupposes that the louse, as a species, can suddenly change its habits and tastes when forced to do so; but to my mind, a new habit is not generally acquired in a species by the simultaneous change of all the individuals composing it, but by some aberrant individual first taking on the new habit, and transmitting that habit to its descendants until a new race is in time produced. A single Clinton vine may stand in the midst of a vineyard of Concords for years, and, as we know to be the case, may be badly infested with this louse without its spreading on to the surrounding Concords. The lice may, and perhaps do, year after year spread on to and settle on the comparatively tougher leaves of such Concords, but year after year they perish from incapacity to sustain themselves. Some day, however, one or more aberrant individuals, may, by some slight constitutional difference from the normal type, be enabled to sustain themselves on the Concord leaves, and, by the laws of inheritance, transmit their characteristics to their descendants until, by the survival of those from each generation best fitted to flourish on these leaves, a new Concord-feeding race will be produced. Therefore, as already stated, I believe that there is danger of this louse spreading on to other varieties, and especially on to such as are more closely allied to the *Cordifolia*, or, to use a common but inexact expression, that have *Cordifolia* "blood" in them. But it must not be forgotten that we are here only supposing, from analogy, what *may* occur, because we know not positively that it *will* occur, and it is very obvious that even if there is this danger the chances of such an occurrence will be far greater as long as the Clinton is allowed to grow in the vineyard, than when it is uprooted and banished; and so far as all experience goes, we can safely conclude that to destroy all those vines in a vineyard that are infested with this louse, is to banish it from such a vineyard so that it will in future confine its attacks to the wild frost, as it did in the beginning.

The Apple-maggot (*Trypeta pomonella*, Walsh), as Mr. Walsh has demonstrated,* is an indigenous American insect and breeds in our

*Report as Acting State Entomologist of Illinois, pp. 29–30.

wild haws, occurring abundantly in the West, as well as in the East. Of late years it has acquired an appetite for the cultivated apples in some of the Eastern States, where it already does much damage to the apple crop. Yet, strange to say, it has not yet, and may never attack the cultivated apples in the West, and there is more danger that in process of time the more civilized Apple-maggots of the East will spread to the West, than that our haw-feeding maggots which are now among us, will acquire that habit, as a race of them once did in the East. Now no one will argue that if the Apple-maggots of the East were to be exterminated, the maggots in the wild haws would any the sooner attack our cultivated apples; and in like manner the extermination of the lice on our Clinton vines will not cause those on the Wild Frost to any the sooner attack our Concords.

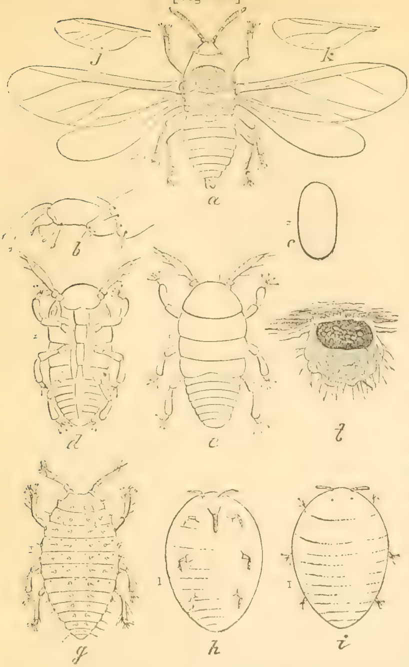
To give another illustration:—Our White pines have for years been greatly injured by the Pine-leaf Scale (*Aspidiotus* [*Mytilaspis*] *pinifoliæ*, Fitch) and I know that this same scale occurs to a slight extent on several other species of the genus, and have good reason to believe that it (or a race of it) is becoming more and more numerous on the Scotch pine around St. Louis. Yet to get rid of this scale I would not hesitate to destroy such White pines as were infested with it, for fear that by such a procedure I should drive the scales on to any other pines; because I believe that the scales on the Scotch pine for instance, multiply among themselves rather than by the annual transportation of individuals from the White pine, and because the experience of the past teaches that the latter is the only pine which has really suffered injury from this scale.

Other similar illustrations might be given, but I close by reiterating the opinion that there is nothing in the past history of the Grape-leaf Gall-louse to warrant the belief that by destroying the Clinton we shall force it on to those more valuable varieties which it has not hitherto attacked, and that whenever, as is admitted to be the case in the central portion of our State, the Clinton can be replaced by other and better varieties, it will be most wise and judicious to discard it. I have no idea that we shall ever exterminate this louse from our vineyards, because we can never obtain concert of action all over the country, and because it will flourish in a measure on other cultivated varieties of the *Cordifolia* group. But let each individual act for himself, and I feel satisfied that so far as he follows the advice here given, just so far will he be benefited.

There are several cannibal and parasitic insects which attack this Gall-louse, but for lack of time to make the proper illustrations, I shall have to leave their consideration to a future Report.

Figure 39, at the head of this article, represents a leaf covered with galls. Figure 40, (*a*) represents the winged female; (*b*) her foot or tarsus—after Signoret; (*c*) an enlarged egg; (*d*) the newly hatched gall-inhabiting type, ventral view; (*e*) same, dorsal view; (*f*)

[Fig. 40.]



a section of a gall; (*g*) the tubercled root-inhabiting form; (*h*) the mother gall-louse at the heighth of her fertility, ventral view; (*i*) same, dorsal view—all from nature; (*j* and *k*) differently veined wings of the Oak *Phylloxera* of Europe. All these figures are greatly enlarged, and the natural size is approximately shown by hair-lines.

The following discussion of this insect's proper place in our classification, and of its characters, may be passed over by the practical reader, as it is intended for those only who take an interest in such questions. I append it with but very slight alteration, as I wrote it for the last number of the second volume of the *American Entomologist:*

It will be remembered that in what was said about this insect on page 248 of our first volume we criticized the founding of the Family *Dactylosphæridæ* by Dr. Shimer. In an essay read before the Illinois State Horticultural Society, at Ottawa, last winter, Dr. Shimer took exception to our remarks, and called upon us to give a reason for the faith that is in us. Not considering a horticultural meeting the proper place to enter into the discussion of purely entomological questions, we declined to waste the precious time of the members, but intimated that we should be glad to answer the Doctor whenever a favorable occasion presented. The opportunity did not offer till now, as the Transactions of the Society, containing the essay in question, have but recently been published, but as we ourselves wrote the strictures, we will briefly give our reasons for so doing. In order to lay the question clearly before those interested, it will be necessary to quote that portion of our former article which so exercised friend Shimer. It runs as follows:

The louse which forms the gall was first described as *Pemphigus vitifoliæ* by Dr. Fitch, of New York, though it does not belong to that genus, Dr. Shimer, of Mt. Carroll, made some interesting observations on the habits of this insect, and made it the type of a new family (*Dactylosphæridæ*) and of a new genus (*Dactylosphæra.*) The distinguishing features of this supposed family are certain appendages attached to the legs which Dr. Shimer calls *digituli*, though the characters of the wings point unmistakably to the genus *Phylloxera* of the true Plant-lice. We shall not now discuss the validity or propriety of this new family, as we intend to give a more complete account of this louse in our future articles on Grape insects; but we will say here that Dr. Shimer is unfortunate in grinding out new genera and new families, for he has proposed a new family and genus (*Lepidosaphes*) for the common Apple-tree Bark-louse (*Aspidiotus*) [*Mytilaspis*] *conchiformis*, Gmél.) based upon similar appendages, which he found on its legs; whereas, if he had been better posted he would have known that these appendages are characteristic of almost all Bark-lice.

And here is Dr. Shimer's appeal:

Here they would like to make the public belive that these appendages, *digituli*, are the characters out of which I have proposed two families in Entomology; whereas, the leading character upon which I propose my family *Dactylosphæridæ*, is two claws on a one-jointed tarsus, and the leading characters in *Lepidosaphidæ* are a tarsus without a claw, and a *scale-making*, not a scale-like insect. The *digituli* from their globe-ended extremities I consider of some importance, but by no means of primary weight in the first named family, and in the second family I give them no more than secondary importance. What reasons the junior editor, for he alone now becomes responsible, can assign for so gross a misrepresentation I am not able to anticipate. He certainly, however, will be able to give some reason for the faith within him. * * * * * * I have not the slightest personal feeling in the matter, and I hope that my much respected friend, Mr. Riley, State Entomologist of Missouri, will be free to defend the position he has taken against me.

Now, we believe Dr. Shimer is sincere in stating that he has no personal feeling in the matter, else we should not even notice his request. We hope, therefore, that he will believe us when we state that in the few words we are about to pen we are governed by no personal considerations whatever, but by a love of truth for truth's sake. As Dr. Shimer becomes more familiar (and we hope he will so become) with the minute and interesting insects to which he has more especially turned his attention, he will no doubt regret that he ever proposed those two families without longer pondering and considering.

Regarding the Bark-louse, we will dismiss the subject in a few words, as it is foreign to the topic under consideration. Dr. Shimer, it is true, deserves severe handling for the cool and skeptical manner in which he refers to the work of all preceding entomologists, and the laughable way in which he arrogates to himself the power of correct observation;* but at present we will simply accede to his request, as follows:

We confess that in stating that Dr. Shimer had based his new family, LEPIDOSAPHIDÆ, upon the occurrence of *digituli*, we should have qualified our language by inserting "partly" before "upon," since the characters as given by him are, *"Four digituli terminated by pulvilli or arolia, and no claw, and the female living beneath a scale or shell-like habitation of her own constructing."** But we insist that the proposition of a family on such grounds was not only unfortunate, but unwarranted, for the following reasons: First, the so-called *digituli* are not even of generic, much less of family value, as they are nothing but modified hairs, and occur in a more or less perfect form in all young *Coccidæ* and *Aphidæ* which we have examined, and are acknowledged by the best authorities to be common to both these families. Secondly, the insect in question really has a more or less perfect claw, as we have abundantly demonstrated the present year. Thirdly, the assumption† that the scale in all COCCIDÆ should be part and parcel of the insect itself, is a purely gratuitous one, since there are many other species which live separate from their scales, and since the genus *Aspidiotus* was especially erected by Bouché for those species which thus live *under* and seperate from them. Consequently there remains not a single character mentioned by our author but what is well known to belong to the COCCIDÆ, and there is not even the slightest excuse imaginable for seperating it from Costa's genus *Diaspis*, to which it is now correctly referred by Signoret—our highest authority on this family.

Now let us return to our Grape-leaf louse. We have no trouble in proving by Dr. Shimer's own words that we were perfectly justified in saying that the "*digituli*" were the "*distinguishing* features" of his supposed family *Dactylosphæridæ*. The very meaning of the word (globe-fingered) given to the family indicates such to have been the case, and he himself expressly says:‡ "The wing neuration of *Dactylosphæra* is synonymous with that of *Phylloxera*; it is, therefore, upon the other characters that I found this genus." Now what are the other characters? Turning to the family characters given, we find: "Wings four, carried flat on the back in repose. Antennæ few-jointed. Tarsi composed of one joint terminated by two claws, and from two to six *digituli*. Honey tubes none; otherwise resembling *Aphidæ*."§ The only other character given which is not Aphidian is the one-jointed tarsus, which, as we shall presently show, cannot, strictly speaking, be considered a character of our Gall-louse, and which, even if it were, would scarcely warrant the making of a new family. Every other character, including the "*digituli*," is common to dozens of plant-lice, and the neuration of the insect's wing‖ places it beyond any doubt in the genus *Pyllox-*

*Trans. Am. Ent. Soc. I, pp. 371-2.

* Trans. Am. Ent. Soc., I, p. 372.

† Ibid, p. 371.

‡ *Characters for a supposed new family*, p. 5, note; from the Proc. Acad. Nat. Sci., Phil., Jan., 1867.

§ Ibid, p. 1.

‖ The neuration of the wing differs slightly from the typical European *Phylloxera quercus*, in the two discoidal veins of the front wing uniting in a fork instead of being perfectly separated. On this account Mr. Walsh proposed for our insect, and for certain other species found in hickory galls, which have the same neuration, the generic name of *Xerophylla*. But it seems to us that the polymorphism of APHIDÆ has not yet been sufficiently investigated to allow of making even different species, much less different genera, upon a forked or unforked nervure, for there is frequently much greater difference in specimens coming from the same parents; and, as we are informed by M. Lichtenstein, the European *Phylloxera* of the Oak actually presents both kinds of neuration;

era, which has long been ready to receive it, and which, with the genera *Vacuna* and *Chermes*, form the sixth Tribe, *Chermesinæ*, of the APHIDÆ, according to Passerini's latest revision of this family.

We can commend the carefulness with which Dr. Shimer made the interesting observations which he has given us on this insect, but no man should undertake to found new families without first informing himself more thoroughly of what has already been done by others.

It was by no very easy means that we arrived at the conclusion that our Gall-louse is identical with the European species, but now that the fact seems sufficiently proved, Planchon's specific name *vastatrix* will have to give way to Fitch's *vitifoliæ*,* or at the most be retained as a variety.

At first there seemed to be many reasons for considering the two insects distinct. First, the European root-louse was exceedingly destructive, and their gall-louse of only exceptional occurrence; while our gall-louse was very common and destructive, and no root-lice were known to exist here at all. Secondly, the insect found in the galls was smooth, while that on the roots was distinctly ornamented with piliferous tubercles, and the two were sufficiently unlike to cause M. Lichtenstein, who believed in their identity, to propose the term gall-inhabiting (*gallicole*) for the one race, and root-inhabiting (*radiciole*) for the other. Thirdly, our insect was described as having a one-jointed tarsus, whereas M. Signoret described and figured the tarsus of the winged root-inhabiting form as two-jointed. Fourthly, there seemed to be a difference even in the form o our gall-inhabiting louse and theirs, as ours appeared much more obese and globular than theirs, as represented in their figures. All these apparent differences were rather calculated to give rise to doubts as to the identity of the two insects; but by careful observation and persistency we have been enabled to dispel them all.

First, we might naturally expect—and those who believe in the Darwinian hypothesis certainly would—that, presuming our insect to have been imported into Europe, it would undergo some modification in its habits, not only because of change of climate, but because of its having to live on another species of the Grape-vine—all the European species belongs to *Vitis vinifera*. Hence its normal habits there, of feeding on the roots, may have been gradually acquired. We believe a parallel case presents itself in our Apple Root-louse (*Eriosoma pyri*, Fitch) and the Wooly Aphis, or so-called "American Blight" (*Eriosoma lanigera*, Hausm). It is conceded on almost all sides† that the last insect was imported into Europe from this country, and there is now every reason to believe that the two insects are identical, or that at furthest they can only be considered as varieties of one species. Yet while in this country our root-louse is very injurious in the West, and only exceptionally found on the limbs above ground (though more often so found in the Eastern States); all authors that we are acquainted with have spoken of it as occurring solely on the limbs in Europe; though M. Lichtenstein informs us that he has found it on the roots also, and that in those cases it caused just such swellings of the roots as our root-louse does here. We know in St. Louis of an old apple-tree, standing in a yard where the ground is trodden hard, the limbs of which have been for the past three years more or less affected with this insect, though none can be found on the roots. But where the ground is more porous, and not so closely pressed to the roots, it seldom occurs on the branches, but often on the roots, even in the immediate neighborhood. Upon the closest examination we cannot find the slightest difference between the root and branch-inhabiting lice,

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there being red specimens with unforked nerves (Fig 40, *j*) and yellow specimens with forked nerves (Fig. 40, *k*). I have in my possession the very drawing made by Mr. Cresson from Dr. Shimer's specimen of *vitifoliæ*, which Mr. Walsh refers to in his Report, and which led Mr. W. erroneously to place our louse with the Coccids. The drawing is rough, evidently imperfect, and well calculated to mislead, for the discoidal nerve of the front wing is represented more as a fold, the forks are omitted, and the costa of hind wing is represented perfectly straight. The drawing is also accompanied by Mr. Cresson's statement that he could not give any decided opinion as to the neuration, as the wings on the specimen were not spread out.

* M. J. Lichtenstein has objected to Fitch's specific name "*vitifoliæ*" on the score of its being ungrammatical, and has substituted the term "*vitis-folii*" in his published reports. Now Dr. Fitch has given the termination "*foliæ*" to a number of his specific names, and though "*folii*" would of course be more grammatically correct, one would suppose the Doctor had some reason for his conduct. At all events I believe it is perfectly proper to drop the middle *s* in compounding the two words, and certain it is that Fitch's term has been adopted by all subsequent writers in speaking of the insect. Irregularities in entomological nomenclature seem to be allowable, or at least are very frequently and purposely perpetrated for the sake of euphony. "Whatever is, is right," is as true in language as it is in religion, and if we alter *vitifoliæ* we must alter a thousand other entomological names that are not, strictly speaking, grammatically correct. It is quite proper to correct a faulty name, but after showing that it is faulty it seems best, to prevent endless confusion, to adopt the faulty name, and thus make its author shoulder the blame, until he himself corrects it.

† M. Eudes-Deslongchamps and M. Blot are the only authors, according to Amyot and Serville, who believe it is indigenous to Europe.

and no doubt their habitat is governed somewhat by the character of the soil, though in this country their normal habit is to attack the roots, and to appear above ground only occasionly in the fall.

Secondly, we have proved, by transferring on to roots the young grape-lice hatched from galls, and by successfully feeding them on those roots, that our smooth gall-inhabiting type gives birth to the tubercled root-inhabiting type; and we have discovered that our gall insects take to the roots in the fall, on which they cause the same cankerous spots and swellings as does the *vastatrix* of Europe, and on which they evidently hibernate just as *vastatrix* is known to do.

Thirdly, although in the gall-inhabiting type, in both countries, the tarsus seems to be one-jointed, yet in the root inhabiting type it is really two-jointed; for though the basal joint is small, and not visible from above, it is plainly visible from the side or from below (See Fig. 40, *b*). We have here what certain speculative entomologists would consider an excellent illustration of the inferiority of Coccidæ compared with the Aphidæ, namely, a true Aphidian, exhibiting in its larval and agamic stage the one-jointed tarsus of a Coccid, and only showing the two-jointed tarsus of its family in the more perfected tubercled form, and in the winged state. And this Coccid-affinity in the less perfect gall-producing state is sometimes carried still farther, as we have often been unable to discern but a single claw to the tarsi of some of the young gall-inhabiting individuals.

Fourthly, the fact that M. Signoret, who alone has compared actual specimens from both countries, decides them to be identical, would sufficiently indicate that the difference noticeable in the form depends on the observer, and on the stage of growth at which observations are made.

It was the one-jointed tarsus in the gall insect which no doubt in part led Dr. Shimer to propose a new family for it, and it was this character—coupled with the facts that it is oviparous, that does not secrete any sugary or flocculent substance (as do most gall-inhabiting Plant-lice), and that the young forsake the gall and scatter over the leaves as soon as hatched—which led Mr. Walsh to consider it as an anomalous and aberrant Coccid. The genus *Phylloxera* seems also, according to Westwood, to have been doubtingly introduced into this family by Curtis in his Guide. We have already shown that, in the root-inhabiting form, the two joints of the tarsus are plainly to be seen; and Dr. Shimer himself admits* that, in the winged insect which he found in galls, he noticed a constriction on the under side of the tarsus, though he is unwilling to allow that it was a joint, because there was no motion. But even if the 2-jointed character of the more perfect ouse were not demonstrated, all the other characters are so unmistakably Aphidian that there is, we think, no warrant in making a new family. In such degraded insects, where the antennal joints are so variable, we might naturally expect to find variation in the joints of the legs. The more familiar we become with the biological secrets of Nature, the more do we find, not only species but genera, and even families, approaching each other through modifications found in individuals; and these aberrant gall-lice only help to give us a better idea of the close connection between the *Coccidæ* and *Aphidæ*. Our *Phylloxera* brings the two families close together, by its affinities on the one side with *Chermes* of Linnæus, which, though looked upon as a Coccid by Ratzeburg, is generally considered an Aphidian, and on the other with the Coccidan genus *Dactylopius* which contains Linnæus's *Coccus adonidum*. The oviparous nature of these gall-lice will also have less significance when we reflect that there is a sort of gradation in this process, and that many Plant-lice which are considered viviparous or ovoviparous do in reality bring forth their young enveloped in a more or less distinct egg-like film or covering, from which they have to free themselves by a process analogous to that of hatching. This has not only been observed by Curtis, in the case of an *Aphis* found on the turnip,† but by Dr. Wm. Manlius Smith, of Manlius, N. Y.,‡ in the case of *Pemphigus*; but we have, the present year, assured ourselves of the accuracy of Dr. Manlius's observation as to *Pemphigus*, and witnessed the same thing in *Eriosoma*, namely in *E. pyri*, Fitch. In this last case the newly deposited louse (or egg) remains motionless for a considerable time; and the covering, after the young louse has extricated itself from it, may be as distinctly seen attached to the end of its body as the covering or egg-shell of our Grape gall-louse, and was figured by Fitch, who mistook it for the cotton-like matter, which, however, is not secreted till the louse fastens itself and begins to grow.§ Moreover those Aphidians which are viviparous through the spring and summer months, generally lay eggs in the fall; and though agamous and viviparous multiplication can be prolonged by submitting the lice to a continued artificially warm temperature, there is doubtless a limit to this prolongation; and it may be laid down as a rule that, with most Aphidians, the ♂ element and the production of eggs are, at some time or other, indispensable to the continuance of the species.

*Characters of a Supposed New Family, p. 3.

†Farm Insects, p. 65.

‡Auctore Walsh, P. E. S. P. VI, p. 282, note.

§N. Y. Rep. I, p. 9.

THE COLORADO POTATO BEETLE AGAIN.

THE BEST MEANS OF FIGHTING IT—A WORD TO OUR CANADIAN NEIGHBORS.

To give some idea of the onward march of this destructive insect, and to lay before the reader the experience that has been gained since the publication of my first Report, I transmit the following article from the *American Entomologist* of last September.

Last July, while spending a few days in Ontario, we ascertained that this most destructive insect had just invaded the Dominion at two different points, namely, near Point Edward, at the extreme south of Lake Huron, and opposite Detroit, near Windsor, at the south-western corner of Lake St. Clair. These are precisely the two points at which we should naturally expect to first meet with it on the Canadian border; for all such beetles as fly into either of the lakes from the Michigan side would naturally be drifted to these points. As we know from experience, many insects that are either quite rare, or entirely unknown on the western side of Lake Michigan, are frequently washed up along the Lake shore at Chicago; and these are so often alive and in good condition, and so often in great numbers, that the Lake shore is considered excellent collecting ground by entomologists. In like manner grasshoppers are often washed up on the shores of Salt Lake, in Utah, in such countless numbers that the stench from their decomposing bodies pollutes the atmosphere for miles around. We have not the least doubt, therefore, in view of these facts, that the Colorado Potato Beetle could survive a sufficient length of time to be drifted alive to Point Edward, if driven into Lake Huron anywhere within twenty or thirty miles of that place, or if beaten down anywhere within the same distance while attempting to cross the lake.*

How truly is Mr. Walsh's prophecy being fulfilled, that the northern columns of this great army would spread far more rapidly than the lagging southern columns.†

Now, what will our Canadian brethren do? Will they stand by and listlessly see this pernicious insect spread over their territory like a devouring flame, as it has done over the Western and Central States; or will they make some determined and united effort to prevent such a catastrophe? Of one thing our friends across the border may rest assured—they have not here a sham and braggart Fenian army to deal with, but an army which knows no retreat, and whose

*The following item which was clipped from the St. Joseph (Mich.) *Herald*, after the above was written, attests the accuracy of the inference:—"Whoever has walked on this shore of Lake Michigan has observed large numbers of the Colorado potato beetle, crawling from the water. Many have doubted the source whence they came. It would seem from the following that they fly, and swim from the western shore of Lake Michigan. Capt. John Boyne of the Lizzie Doak, reports finding his deck and sails infested with potato bugs when half way from Chicago to St. Joseph at night. Not a bug was on deck when the schooner left Chicago."

†*Practical Entomologist*, I, p. 14.

embers, though of small and insignificant stature, will fully make up in number what they lack in size.

When we calculate the immense loss, amounting to millions of dollars, which this insect has cost the Western States during the past nine or ten years—when we contrast the healthful and thrifty aspect of the potato fields in Ontario and in those States to which this potato plague has not yet spread, with the sickly, denuded, or Paris-green-besmeared fields at home—but above all when we reflect that, nothing preventing, it will infest the whole of Ontario within, perhaps, the next two, and at farthest within the next three years—we feel that it is high time to make some effort to prevent its onward march through Ontario, if ever such an effort is to be made. The warnings and instructions given by the Agricultural press, and through our own columns, will avail but little, as they reach the few only. It may be, and doubtless is, true that successful culture, as our country becomes more thickly settled, will be confined to the intelligent and well-informed; yet the fact nevertheless remains, that the masses will do nothing to ward off an evil until they are forced to it from necessity. The plodding, non-reading farmer will take no notice of the few bugs he first sees in his potato field, because they do him no material injury; but when the bugs have increased so as to make it a question of "potatoes or no potatoes" with him, then his energies will be aroused. But alas! his best efforts, at this time, often prove unavailing, and he has to spend days to accomplish that which a few minutes would have accomplished before. We therefore fully expect to see this great army of bugs continue its eastward march without hindrance, unless other preventive measures are taken than those already employed. A standing premium offered by the Minister of Agriculture, Mr. Carding, for a given number of beetles, or for the greatest number collected and killed in one season, or for the cleanest and best field of potatoes, of a given number of acres, within the infested districts along the eastern shores of the lakes mentioned and those of the St. Clair river; might, and undoubtedly would, be the best means of stamping it out, and of keeping it out of the Dominion.*

No doubt that, in suggesting any expenditure of money for such purposes, our Canadian brethren will deem us over-enthusiastic about "small things," and over-anxious for their welfare. Well, be that as it may, we don't forget that there is considerable of Uncle Sam's territory beyond Niagara. It is a mere matter of dollars and cents, and we venture to say that, when once this insect shall have spread over Ontario, a million dollars would be freely spent to accomplish that which will then be almost impossible, and which a very few thousands would effectually accomplish now—namely, its extermination from the Dominion.

An excellent chance is now afforded in Ontario—almost surrounded as it is by lakes—to keep this destructive enemy at bay. In the summer of 1869, reports of this insect's ravages, and of its progress eastward, came thick from Wisconsin and Indiana; but no organized effort was made to check it, and indeed there was very little chance of doing so. It is fast spreading through Ohio; and according to Dr. Trimble of New Jersey, has already reached Pennsylvania. Uncle Sam cannot well prevent its spread around the southern shore of Lake Erie, through Pennsylvania and eastward; but, if it can be effectually resisted between Point Edward and the Detroit river, there will be little difficulty in preventing its crossing at Niagara. A victory would indeed be gained if, by intelligent effort, this grievous pest could be kept out of Upper Canada, while it is devastating the potato fields on all sides in the States; and Minister Carding would add to his well-deserved popularity by making the effort, whether it succeeds or not.

PARIS GREEN A REMEDY.

While on this subject it may be well to say a few words about the use of Paris green. This substance has now become THE remedy for the Colorado Potato Beetle, and it is the best yet discovered. Having thoroughly tested it ourselves, and having seen it extensively used, we can freely say that, when applied judiciously, it is efficient and harmless. If used pure and too abundantly, it will kill the vines as effectually as would the bugs, for it is nothing but arsenite of copper (often called "Scheele's green" by druggists), and contains a varied proportion of arsenious acid, according to its quality—often as much as fifty-nine per cent., according to Brande & Taylor. But when used with six to twelve parts, either of flour, ashes, plaster or slacked lime, it causes no serious injury to the foliage, and just as effectually kills the bugs. The varied success attending its use, as reported through our many agricultural papers, must be attributed to the difference in the quality of the drug.

We hear many fears expressed that this poison may be washed into the soil, absorbed by the rootlets, and thus poison the tubers; but persons who entertain such fears forget that they themselves often apply to the ground, as nourishment for the vines, either animal, vegetable or mineral substances that are nauseous, or even poisonous to us. Animal and vegetable substances, of whatsoever nature, must be essentially changed in character and rendered harmless before they can be converted into healthy tubers, and a mineral poison could only do harm by being taken with the potatoes to the table. That any substance, sprinkled either on the vines or on the ground, would ever accompany to the table a vegetable which develops underground, and which is always well cooked before use, is

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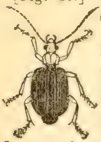
* The Rev. C. J. S. Bethune, in the *Canada Farmer* for October 15th, 1870, also recommended the marking off of a tract of country about ten miles in width, all along the border line between the foot of Lake Huron and the head of Lake Erie, with the exception, possibly, of a portion of the eastern shore of Lake St. Clair, and stopping the culture of the potato throughout that whole tract during the prevalence of the pest in the neighboring State of Michigan.

rendered highly improbable. There can be no danger in the use of sound tubers. But the wise and well-informed cultivator will seldom need to have recourse to Paris green, as he will find it more profitable to use the different preventive measures that have from time to time been recommended in these colums.

The poison may do harm, however, by being carelessly used, and it is most safely applied when attached to the end of a stick several feet long, and should not be used where children are likely to play.

NATURAL CHECKS INCREASING.

[Fig. 41.]



In many parts of the West this insect is being kept in due check by its cannibal and parasitic enemies, which are still increasing. Thus we learn from many sources that in Iowa and Kansas it is not nearly so injurious as it formerly was, while in some parts of Illinois and Missouri it has also become less troublesome. Last year Mr. T. Glover published the fact that the Great Lebia (*Lebia grandis*, Hentz, Fig. 41) was found devouring its larvæ,* and though hitherto considered rare this Lebia has suddely fallen upon it the present year in many parts of Missouri. During a recent trip along the Missouri Bottom we found this cannibal very abundant in some potato fields belonging to Mr. Wm. Coleman, where it was actively engaged in destroying both the eggs and larvæ of the Potato Beetles. The head, thorax and legs of this cannibal are yellowish-brown, in high contrast with its dark-blue wing-covers.

This makes fourteen conspicuous enemies of our Colorado Potato Beetle which we have figured, and a dozen more, mostly of small size and inconspicuous markings, might easily be added to the list. Moreover, chickens have learned to relish the eggs, and have even acquired a taste for the young larvæ. So we need not wonder that the army is being decimated in those States first invaded by it.

BOGUS EXPERIMENTS.

It was recently reported to us that a neighbor had succeeded in driving away all his Potato bugs by strewing Elder branches among the vines. We went to examine the field and found our friend enthusiastic over his discovery; and indeed though the vines were nearly devoured, there were but a few full grown larvæ to be found. But, as he could not tell us what had become of the "slugs," we undertook to show him where they had gone, and after digging a few moments with a trowel, unearthed dozens of them, the majority in the pupa, but a few yet in the larva state. Our neighbor had, in fact, been misled by appearances, for want of better knowledge of his enemy. The larvæ as they acquired their growth suddenly became so destructive, that to save his vines he was obliged to try some means of killing them,

* Dept. of Agr. Rep. 1868, p. 81.

and as an experiment he tried the Elder. The larvæ were just ready to disappear of their own accord, and as the great bulk of them did really disappear in two or three days after the application, the apparently logical inference was made that they had been driven away by the smell of the Elder.

How many of the published remedies that flood the country owe their origin to just such defective proof! The sun-scorching remedy, which consists of knocking the bugs off the vines on to the heated ground between the rows, and which has been so often recommended the present year, partakes a good deal of this character; for it can only be of benefit in a very dry season, and at a time of year when the bugs have done most of their damage. A goodly proportion of the larvæ that are thus knocked off will always manage to burrow into the ground and transform, or to get back upon the vines; and

THE TRUE REMEDY

consists in preventing them from becoming numerous so late in the season. Watch for the beetles in early spring, when the vines are just peeping out of the ground. Ensnare as many of them as you can before they get a chance to pair, by making a few small heaps of potatoes in the field planted: to these the beetles will be attracted for food, and you can easily kill them in the morning. Keep an eagle eye for the eggs which are first deposited. Cultivate well, by frequently stirring the soil. Plant early varieties in preference to late ones because the bugs are always more numerous late in the season than they are during the spring and early summer. Give the preference to the Peach Blow, Early Rose and such other varieties as have been found most exempt from attack,* and surround your fields on the outside by rows of such tender-leaved varieties as the Mercer, Shaker, Russet, Pink-eye and Early Goodrich; but, above all, isolate your potato field as much as possible, either by using land surrounded with timber, or by planting in the centre of a cornfield. Carry out these suggestions thoroughly and you will not have much use for Paris green and still less for the scorching remedy.

THE CODLING MOTH AGAIN.—*Carpocapsa pomonella*, Linn.

HAY-BANDS VS. RAGS—ALWAYS TWO-BROODED IN MISSOURI.

After a series of experiments, instituted the past summer, I have proved that, after all, the hay-band *around* the trunk of the tree is a

* After experimenting last summer with eighty-one varieties of potatoes, the Superintendent of the garden of the Iowa Agricultural College reports the varieties of the Peach Blow, the Peerless and Chili No. 2, as most exempt from the ravages of this insect, the last named variety not being worked upon at all.

more effectual trap for the Apple-worm than the rags placed in the *fork* of the tree. There is no superiority in the rags over the hay-band, unless the former are made to encircle the tree as thoroughly as the latter. Where rags are placed simply in the forks, many of the worms pass down the tree from the outside of the branches. If the rag is tied around the trunk, it will impede almost every worm that crawls down the tree from the fruit which hangs on, or that crawls up the trunk from the fruit which alls; and it then has a decided advantage over the hay band, because it can either be passed through a roller or scalded, and used again.

It has been very generally accepted in this country that the Codling Moth is double-brooded, and in all my writings on the subject I have stated it to be so, though no one, so far as I am aware, ever proved such to be the case beyond a doubt. Mr. P. C. Zeller, of Stettin, Prussia, informed me last winter that it is only single-brooded in that part of the world, and Harris gives it as his opinion that it is mostly so in Massachusetts. Now, such may not improbably be the case in northern Prussia, and the more northern of the United States, though I incline to believe otherwise. At all events, this insect is invariably double-brooded in the latitude of St. Louis, and its natural history may be briefly told as follows: The first moths appear, and begin to lay their eggs, soon after the young apples begin to form. The great bulk of the worms which hatch from these eggs leave the fruit from the middle of May to the middle of June. These spin up, and in from two to three weeks produce moths, which pair and in their turn commence, in a few days, to lay eggs again. The worms (second brood) from these eggs leave the fruit, some of them as early as the first of September, others as late as Christmas. In either case they spin their cocoons as soon as they have left the apples, but do not assume the pupa state till towards spring—the moths from the late matured worms appearing almost as early as those from the earlier matured ones. The two broods interloc so that in July worms of both may be found in the fruit of one and the same tree. I have repeatedly taken worms of the first brood, bred the moths from them, and obtained from these m ths the second brood of worms; and I have done this both on enclosed fruit hanging on the tree in the open air, and on plucked fruit in-doors. In the latter experiments the moths would often cover an apple with eggs, so that when the worms hatched they would enter from all sides, and soon so thoroughly perforate and devour the fruit as to die of starvation. This is a clear case of misdirected instinct in the parent, caused doubtless by confinement.

From the foregoing facts, it becomes obvious that the rags or the hay-band should be kept around the tree, say from the first of May till the fruit is all off; and to be thoroughly effectual, the insects collected in or under them should be destroyed regularly every fortnight during that time.

There is a fact connected with the Codling Moth which, though of interest to entomologists is not generally known, and has never been published in this country. It has always been difficult to distinguish the sexes of this moth, but there is an infallible index recently pointed out by Mr. Zeller in his "Lepidopterologische Beobachtungen im jahre 1870." It consists of a black pencil or tuft of hairs of considerable length on the upper surface of the hind wings. It springs from a point close to the base of the wing and by the side of the median nervure, and lies in a groove running alongside of that nervure to about half the width of the wing, the groove forming a distinct carina on the under surface. The tuft when closely fitted into this groove is not easily noticed, but since my attention has been drawn to it, I have readily detected it on all my cabinet specimens, and it can easily be raised by the point of a needle.

Thus we find that important features are often revealed upon close scrutiny of our commonest insects, and the fact that this feature was so long overlooked in our Codling Moth should teach us to be all the more careful and cautious in our examinations and descriptions. Two similar instances of general oversight of common features in common insects were pointed out to me last fall by that excellent observer, Mr. J. A. Lintner, of the Agricultural Rooms, Albany, N.Y., who ascertained the facts that in the Butterfly genus *Argynnis* the males have invariably a beautiful fringe of hair on the sub-costa of the hind wings, while the females have not; and that in the genus *Grapta* the males have hairy front legs while the females have not.*

In my first Report (p. 65) I mentioned as an exceptional occurrence that this insect had been found quite injurious to plums around London, Ontario; but it has not hitherto been recorded as infesting peaches. Mr. Huron Burt, of Williamsburg, Callaway county, informs me, however, that three-fourths of the peaches in his vicinity were infested with this worm, and that it was more abundant in this stone-fruit than in apples, though its gnawings in the former are not followed by the same serious consequences as they are in the latter. In the peach the worm always lives near the stone, and bores no other holes through the flesh than the one required for egress, and the excrement is packed close to the stone, so that the fruit is generally but little injured for eating, cooking, drying or other purposes. Mr. Burt did not actually breed the moths from these peach-inhabiting worms, but as he is one of my most valued correspondents and an excellent observer and has paid considerable attention to insects, I have little doubt but that he is correct in concluding that they were the larvæ of the Coddling Moth, the more especially as he has fur-

* The first mentioned feature, as a secondary sexual character, has long since been pointed out, and according to Mr. H. W. Bates (Trans. Linn. Ent. Soc., Vol. XXIII, p. 502, 1861) is common to all the tropical genera but two (*Lycorea* and *Ituna*) composing the Danoid *Heliconidæ*. Yet Mr. Lintner's observation is certainly original in this country, for, striking and useful as the feature is as a sexual characteristic, it is never given in the beautiful plates of Mr. Edwards's "Butterflies of North America."

nished me, in detail, his reasons for this conclusion; but until the matter is settled beyond all doubt it would be premature to speculate farther on such a new and remarkable habit in such a common and well known insect.

THE CORN-WORM *alias* BOLL-WORM—*Heliothis armigera*, Hübner.

(Lepidoptera, Noctuidæ.)

This is a worm which is every year more or less destructive to our corn in the ear, and which was this year very injurious in many sections.

It has a very wide range, and a Mr. Bond, at the meeting of the London (England) Entomological Society, on March 1st, 1869, exhibited specimens of the moth from the Isle of Wight, from Japan, and from Australia; and, as might be expected from its extended habitat, the insect is a very general feeder. The "Boll-worm" has become a by-word in all the Southern cotton-growing States, and the "Corn-worm" is a like familiar term in those States, as well as in many other parts of the Union; but few persons suspect that these two worms—the one feeding on the corn, the other on the cotton-boll—are identically the same insect, producing exactly the same species of moth. But such is the fact, as I myself first experimentally proved in 1864. It attacks corn in the ear, at first feeding on the "silk," but afterwards devouring the kernels at the terminal end; being securely sheltered the while within the husk. I have seen whole fields of corn nearly ruined in this way, in the State of Kentucky, but nowhere have I known it to be so destructive as in Southern Illinois. Here, as in our own State, there are two broods of the worms during the year, and very early and very late corn fare the worst; moderately late and moderately early varieties usually escaping. I was formerly of the opinion that this worm* could not live on hard corn, and it certainly does generally disappear before the corn fully ripens, but last fall Mr. James Harkness, of St. Louis, brought me, as late as the latter part of October, from a corn field on the Illinois bottom, a number of large and well ripened ears, each containing from one to five worms of different sizes, subsisting and flourishing on the hard kernels. This is, however, an exceptional occurrence, brought about, no doubt, by the long protracted warm weather which we had, and the worms were in all probability a third brood.

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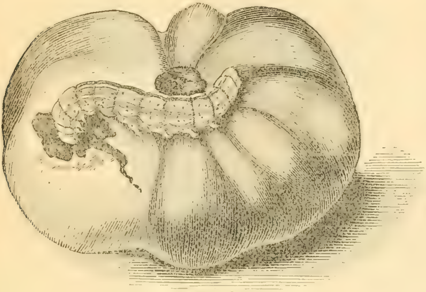
* Am. Ent. I, p. 212.

This glutton is not even satisfied with ravaging these two great staples of the country—cotton and corn—but, as I discovered in 1867, it voraciously attacks the tomato in South Illinois, eating into the green fruit, (Fig. 42), and thereby causing such fruit to rot. In this manner it often causes serious loss to the tomato-grower, and it may justly be considered the worst enemy to the tomato in that section of the country. Mr. Glover also found it feeding in a young pumpkin, and it has been ascertained by Mrs. Mary Treat of Vineland, New Jersey, not only to feed upon the undeveloped tassels of corn and upon green peas, but to bore into the stems of the garden flower known as Gladiolus, and in confinement to eat ripe tomatoes. Last summer it was also found by Miss M. E. Murtfeldt in common string beans, around Kirkwood, and in Europe it is recorded by M. Ch. Goureau* as not only infesting the ears of Indian corn, but as devouring the heads of hemp, and leaves of tobacco, and of lucern. The fact of its attacking a kind of pea, namely, the chick-pea or coffee-pea (*Cicer arietinum*) has also been recorded by M. J. Fallou (See *Insectologie Agricole*, 1869, p. 205) in certain parts of France, the young worms feeding on the leaves but the larger individuals boring through the pods and devouring the peas.

[Fig. 42.]



Thus it seems to be almost as promiscuous in its tastes as the Stalk-borer (*Gortyna nitela*, Guen.), which burrows in the stalks of the Potato, of the Tomato, of the Dahlia, of the Aster and other garden flowers, of the common Cocklebur and of Indian corn, besides boring into green corn-cobs and eating into green tomatoes and ripe strawberries, and in a single instance in Missouri eating into peach twigs, and in Illinois inhabiting the twigs of the Black Currant.†

But for the present we will consider this insect only in the two roles of Boll-worm and Corn-worm, because it is as such that it interests the practical man most deeply.

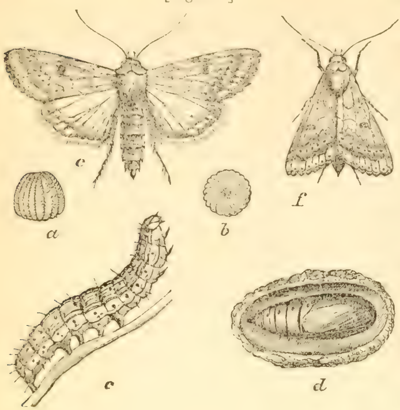
The egg from which the worm hatches (Fig. 43, *a* side view; *b*, top view magnified) is ribbed in a somewhat similar manner to that of the Cotton-worm, figured in my Second Report (p. 38) but may readily be distinguished by being less flattened, and of a pale straw color instead of green. It is usually deposited singly on the outside

* *Insectes Nuisibles*, 2nd supplement, 1865, p. 132.

† See *Am. Ent.* I. p. 206; II. p. 13.

of the involucel or outer calyx of the flower or young boll, and each female moth is capable of thus consigning to their proper places, upwards of five hundred eggs. Mr. Glover, in his account of the Boll-worm, published in the Monthly Report of the Department of Agriculture for July, 1866, says: "Some eggs of the Boll-worm moth hatched in three or four days after being brought in from the field, the enclosed worms gnawing a hole through the shell of the egg and then escaping. They soon commenced feeding upon the tender fleshy substance of the calyx, near the place where the egg had been deposited. When they had gained strength, some of the worms pierced through the calyx, and others through the petals of the closed flower-bud, or even penetrated into the young and tender boll itself. The pistils and stamens of the open flower, are frequently found to be distorted and injured without any apparent cause. This has been done by the young Boll-worm; when hidden in the unopened bud, it has eaten one side only of the pistils and stamens, so that when the flower is open the parts injured are distorted and maimed, and very frequently the flower falls without forming any boll whatever. In many cases, however, the young worm bores through the bottom of the flower into the immature boll before the old flower falls, thus leaving the boll and involucel or envelope still adhering to the foot-stalk, with the worm safely lodged in the growing boll. The number of buds destroyed by this worm is very great, as they fall off when quite small, and are scarcely observed as they lie brown and withering on the ground beneath the plant. The instinct of the Boll-worm, however, teaches it to forsake a bud or boll about to fall, and either to seek another healthy boll, or to fasten itself to a leaf, on which it remains until at length it acquires size and strength sufficient to enable it to bore into the nearly matured bolls, the interior of which is nearly destroyed by its attacks, as, should it not be completely devoured, rain penetrates through the hole made by the worm, and the cotton soon becomes rotten and will not ripen. * * * * * * * *

[Fig. 43.]



One thing is worthy of observation, and that is, whenever a young boll or bud is seen with the involucre spread open, and of a sickly yellow color, it may be safely concluded that it has been attacked by the Boll-worm, and will soon perish and fall to the ground. * * *

The buds injured by the worm may be readily distinguished by a minute hole where it has entered, and which, when cut open, will be found partially filled with small black grains, something like coarse gun powder, which is nothing but the digested food after having passed through the body of the worm."

This insect is very variable in the larva state, the young worms varying in color from pale green to dark brown. When full grown there is more uniformity in this respect, though the difference is often sufficiently great to cause them to look like distinct insects. Yet the same pattern is observable, no matter what may be the general color; the body being marked as in the above figures with longitudinal light and dark lines, and covered with black spots which give rise to soft hairs. Those worms which Mrs. Treat found in green peas and upon corn tassels had these lines and dots so obscurely represented that they seemed to be of a uniform green or brown color, and the specimens which I saw last summer in string beans were also of a dark glass green color with the spots inconspicuous, but with the stripe below the breathing pores quite conspicuous and yellow. The head, however, remains quite constant and characteristic. Figure 42 may be taken as a specimen of the light variety, and Figure 43, *c*, as illustrating the dark variety. When full grown, the worm descends into the ground, and there forms an oval cocoon of earth interwoven with silk, wherein it changes to a bright chestnut-brown chrysalis (Fig. 43, *d*), with four thorns at the extremity of its body, the two middle ones being stouter than the others. After remaining in the chrysalis state from three to four weeks, the moth makes it escape. In this last and perfect stage, the insect is also quite variable in depth of shading, but the more common color of the front wings is pale clay-yellow, with a faint greenish tint, and they are marked and varigated with pale olive and rufous, as in Figure 43, (*e* showing the wings expanded, and *f* representing them closed), a dark spot near the middle of each wing being very conspicuous. The hind wings are paler than the front wings, and invariably have along the outer margin a dark brown band, interrupted about the middle by a large pale spot.

Mr. Glover says that there are at least three broods each year in Georgia, the last brood issuing as moths as late as November. With us there are usually but two, though, as already hinted, there may be exceptionally three. Most of the moths issue in the fall, and hibernate as such, but some of them pass the winter in the chrysalis state and do not issue till the following spring. I have known them to issue, in this latitude, after the 1st of November, when no frost had previously occurred.

In 1860—the year of the great drought in Kansas—the corn crop in that State was almost entirely ruined by the Corn-worm. According to the *Prairie Farmer*, of January 31, 1861, one county there which raised 436,000 bushels of corn in 1859, only produced 5,000 bushels of poor wormy stuff in 1860; and this, we are told, was a fair sample of most of the counties in Kansas. The damage done was not by any means confined to the grain actually eaten by the worm; but "the ends of the ears of corn, when partially devoured and left by this worm, afforded a secure retreat for hundreds of small insects, which, under cover of the husk, finished the work of destruction commenced by the worm eating holes in the grain or loosening them from the cob. A species of greenish-brown mould or fungus grew likewise in such situations, it appearing that the dampness from the exuded sap favored such a growth. Thus decay and destruction rapidly progressed, hidden by the husk from the eye of the unsuspecting farmer." It appears also that many horses in Kansas subsequently died from disease, occasioned by having this half-rotten wormy corn fed out to them.

Remedies.—It is the general experience that this worm does more injury to very early and very late corn than to that which ripens intermediately, for though the broods connect by late individuals of the first and early individuals of the second, there is nevertheless a period about the time the bulk of our corn is ripening, when the worms are quite scarce. I have never yet observed their work on the green tassel, as it has been observed in New Jersey, and do not believe that they do so work with us. Consequently it would avail nothing as a preventive measure, to break off and destroy the tassel, and the only remedy when they infest corn is to kill them by hand. By going over a field when the ears are in silk, the presence of the worms can be detected by the silk being prematurely dry or by its being partially eaten.

In the South various plans have been adopted to head off the Boll-worm, but I believe none have proved very successful. The following experiment with vinegar and molasses, was made by B. A. Sorsby, of Columbus, Ga., as quoted by Mr. Glover:

"We procured eighteen common-sized dinner plates, into each of which we put half a gill of vinegar and molasses, previously prepared in the proportion of four parts of the former to one of the latter. These plates were set on small stakes or poles driven into the ground into the cotton field, one to about each three acres, and reaching a little above the cotton plant, with a six-inch square board tacked on the top to receive the plate. These arrangements were made in the evening, soon after the flies had made their appearance; the next morning we found eighteen to thirty-five moths to each plate. The experiment was continued for five or six days, distributing the plates over the entire field; each day's success increasing until the numbers were reduced to two or three moths to each plate, when it was abandoned as being no longer worthy of the trouble. The crop that year was but very little injured by the Boll-worm. The flies were caught in their eagerness to feed upon the mixture by alighting into it and being unable to escape. They were probably attracted by the odor of the preparation, the vinegar probably being an important agent in the matter. As the flies feed only at night, the plates should be visited late every evening, the insects taken out, and the vessels replenished as circumstances may require. I have tried the experiment with results equally satisfactory, and shall continue it until a better one is adopted."

Mr. J. M. Heard, of Monroe county, Wisconsin, patented in 1860, a device for trapping the moth, which consists of a tin plate placed on a funnel, which is connected with a bait-pan made of the same material, and which is to be partially filled with molasses mixed with a little anise, fennel or other essential oil. From one summer's test of the trap, I do not think much of it as a decoy for the moth, and it would be altogether too expensive, when the great number required to properly protect a large cotton field is taken into consideration.

THE FALL ARMY-WORM—*Prodenia autumnalis*, Riley.

[Lepidoptera, Noctuidæ.]

In 1868 the true Army-worm appeared in certain portions of the State and I gave a full account of it in my second Report. Last fall another worm very generally mistaken for that insect made its appearance very generally over the State, and caused considerable alarm. Specimens were sent to me from Moniteau, Jefferson, Pulaski and Cole counties, while it was common throughout the greater portion of the county of St. Louis.

The first notice I received of it was from the following item which appeared in the *Journal of Agriculture* of St. Louis:

ARMY WORM.—*Editors Journal Agriculture:* Since Friday (26th August), the Army-worm has made its appearance in distressingly large numbers almost everywhere in this (Cole) county. They have destroyed for me more than an acre of turnips, a good deal of my late soiling corn, and are still on the march for more. Farther in the country they have eaten up the buckwheat, which is just coming into bloom. Could our esteemed friend RILEY give us an article in the next *Journal?—F. A. Nitchy.*
JEFFERSON CITY, Mo., August 29th, 1870.

The following published paragraphs, which all refer to this same worm, and which chanced to meet my eye, will give some idea of the extent of country through which it ranged.

FALL ARMY-WORM.—We have received specimens of the Fall Army worm from several persons. The complaints of its ravages are quite numerous almost all over the State; they are very bad in northeast Missouri. Threatening at Tipton, from which place we have samples, and in St. Louis and Jefferson counties they are quite bad. This pest only returns at intervals, perhaps on account of parasitic and other enemies gaining the ascendancy over them.—*Rural World. Sept. 2nd,* 1870.

ARMY-WORM IN CALLAWAY COUNTY.—I have found that the Army-worm has been more or less on almost every farm, and have been examining some of the meadows over which they have passed, and have come to the conclusion they are about ruined. From my examination I think that nineteen-twentieths of the grass is entirely killed; at least there is not more than one bulb in twenty that shows any signs of vitality. Why should this insect make its appearance at this season? Mr. Riley, I believe claims that it makes its advent in the spring. But now we have it appearing at the end of summer and beginning of fall, and in numbers as great and as destructive as ever it did in spring. Could it be that the extreme heat of this season, with favorable conditions of moisture, has brought them forth prematurely? I noticed that some plum trees, cherry trees, smoke trees, summer roses and strawberries are blossoming freely from premature development.—*H. B., Journal of Agriculture, Oct. 13th*, 1870.

The Army-worm, on the 28th of August, appeared in force in my neighbor's wheat stubble, moving south towards a piece of land that I had planted in corn, and then sown in rye that was up nicely. When they reached the fence (which they did on the 28th of August), I scattered salt thickly on the rich blue grass on my side of the fence, all along it, while the dew was on. They came no further. As I was obliged to be away from home, I cannot say whether the salt checked them or not—at any rate, it caused the grass to wilt and die.

A very small dark worm about half an inch long, has been doing some damage to the young grain of late.—*J. L. Erwin, Fulton, Callaway County, Mo.*

THE ARMY-WORM—A SLANDER ON THE BIRDS—*Editor Farmer:* Feeling it a duty, as well as a privilege, to contribute all good, or even really bad news for the farmers, through your truly valuable and very much improved and highly esteemed Farmers' journal, enclosed (in a small phial) please find some specimens of Army-worm. many millions of which infest our county. They are everywhere. It is said they are brought by a small, yellow bird, which goes in covies of twenty-five to two hundred—that wherever they alight, the worms first appear. It is said that each petaled portion of the feathers is covered with nits, and their number is legion.

We would be pleased to hear from some of our scientific men on the subject, as we are very much interested. They take a twenty-acre wheat field in two days.

These pestiferous little pests are rapidly arriving at maturity. In traveling, their course seems westward. They last appeared here in 1865, but too late in the season to do any great damage, as a cold rain sent them the way of all the earth. That being in October, nothing of the kind can be expected at this time; and if they are to remain here until October, woe to our wheat fields in this vicinity!

MINERAL POINT, Kansas, Aug. 29th, 1870.

[The above letter came to us too late for insertion last month. Our friends are doing great injustice to our little harmless "Prairie-birds," in supposing that they have anything to do with bringing the Army-worm—EDITOR].—*Kansas Farmer, October*, 1870.

ARMY WORM.—Late rains are keeping corn too green. Too muddy to plow for wheat. The Hessian-fly and Army-worm are too numerous to allow farmers to seed much this fall. The early sown wheat and much of the meadows are eaten up by the Army-worm. Dr. C W. Thornton, of Warrensburg, Kansas, in *Kansas Farmer.*

Army-worm.—We have received from S. S. Tipton, of Mineral Point, a specimen of the above genius, but a little the worst demoralized specimen we ever saw. The bottle was broken, and, as well as we can determine, by the aid of a powerful magnifying glass, the worm is in about sixty thousand pieces. We shall refer to the subject in our next; but in the mean time, we advise our friends to plow and scrape out ditches, in which to spread dry straw. Then muster your force armed with brushes, drive them into the ditches, and set fire to the straw. We have seen them very successfully treated in this way. *Kansas Farmer.*

Thus in all the above accounts this worm was supposed to be a fall brood of the true Army-worm, and in the following letter, we shall see that it was also mistaken for the Corn-worm treated in the last article—a mistake not at all surprising considering the close resemblance between the two worms,

C. V. Riley, Dear Sir.—I herewith send you a box of what I believe to be the Boll-worm although its actions here were similar to the true Army-worm. At my father's and in the neighborhood they complain too of *the Army-worm* eating up the young oats and timothy. With me they commenced about two weeks ago in a field of young oats, or rather oat stubble which had been plowed under and sown to buck-wheat. The oats had got to be about six inches high and were eaten first, next the worm took what little crab grass they could find and they are now scattered, eating grass, corn silks, soft corn, rutabaga leaves and whatever in the grass line comes before them. They have not entered my meadow yet, nor a piece of wheat stubble which is plowed under. G. Pauls.

Eureka, Mo., Sep., 7, 1870.

On the farm of Jno. J. Squires at DeSoto, this worm at first ate off all the grass, then completely stripped the leaves from some corn-fodder, injured his corn, ate into his tomatoes and ruined his turnips —injuring his crops to the amount of nearly $1,000.

In some cases the worm acted strangely, and I have know it to take a whole field of rye in preference to wheat. Judge Wielandy, of Cole county informs me that it was abundant on his potatoes, cutting off the lateral stems. It invaded a large cucumber field and entirely cleaned out the crab grass, and would have injured his cucumbers had he not applied slacked lime. In some parts of Jefferson county it was very abundant and destructive, and Senator J. H. Morse, of Morse's Mills had twenty acres badly injured by it. I have also been informed that in some vineyards it did great damage by gnawing around the stems and causing the bunches to drop off and fall to pieces so that the grapes would scatter on the ground. But I cannot vouch for the correctness of the observation. With me it did more injury to corn than to anything else. It not only greedily devours the leaves and stems, but bores large holes through the ears, burrowing in them in all directions. On late corn it is frequently found in the same ear with the Corn-worm, *alias* Cotton Boll worm. The Boll-worm is, however, rougher, generally paler, striped differently (see Figs. 42 and 43, *c*.), and always readily distinguished by having a larger gamboge-yellow or reddish head, which invariably lacks the distinct white inverted Y-shaped mark, and the darker shadings of the head of the Fall Army-worm.

Now, until the present year nothing was absolutely known of the natural history of this worm, and though I knew that it was not the true Army-worm, and suspected, from comparing it with the description of certain corn-feeding worms received in 1868 from Mr. E. Daggy, of Tuscola, Illinois, that it would produce a certain moth which I bred from Mr. Daggy's worms—yet I could not feel positive without breeding the Fall Army-worm to the perfect state. This I very luckily did, and I am therefore able to give its complete history.

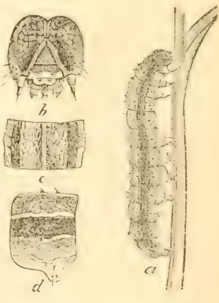
In the fall of 1868 I received a few specimens from Mr. T. R. Allen, of Allenton, with an account of their injuring newly sown wheat on oat stubble, and on page 88 of my first Report it was briefly described by the name of Wheat Cut-worm. The popular term of "Fall Army-worm" is, however, altogether more indicative than that of "Wheat Cut-worm," since the species does not confine its attacks to wheat, and not only very closely resembles the Army-worm in appearance but has many habits in common.

HOW IT DIFFERS FROM THE TRUE ARMY-WORM.

The two insects need never be confounded, however. The true Army-worm never appears in the fall of the year, but always about the time when wheat is getting beyond the milk state; and it generally disappears, in the latitude of St. Louis, by the first of June. It confines its attacks entirely to the grasses and cereals, whereas the species under consideration is a much more general feeder, devouring with equal relish most succulent plants, such as wheat, oats, corn, barley, grasses, purslane, turnips, and, as Mr. J. M. Jordan of St. Louis informs me, even spruces. Moreover, when critically examined, the two worms show many characteristic differences, as will be seen by comparing Figure 44, which represents the true Army-worm, with Figure 45, which represents at *a* the Fall Army-worm natural size, at *b* its head magnified, at *c* a magnified dorsal view of one of the joints, and at *d* a magnified side view of same.

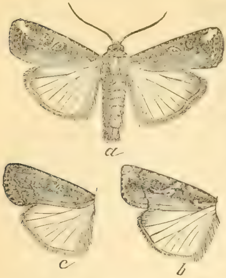
[Fig. 44.]

[Fig. 45.]



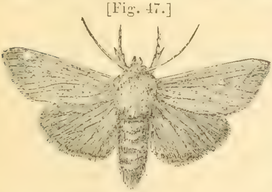
Our Fall Army-worm moth is a most variable one—so variable, indeed, that at least three species might easily be fabricated by any species-grinder who happened to capture at large the three most distinct varieties, without knowing anything of their transformations. I have bred 31 specimens, all from larvæ found on corn, and have others which were captured at large, and though half a dozen sufficiently distinct varieties might easily be picked out from among them, and though scarcely any two are precisely alike, yet they may all be divided into three distinct sets or varieties. The first of these, which is the more common, is represented at Figure 46, *a*, the second at *b*, and the third at *c*. For those who are more curious in such matters I append, at the end of this article, a more elaborate description of this new moth. Not only do I find this great variation in this particular species, but all the species of the genus to which it belongs are variable; and Guenée has truly remarked that they resemble each other so closely, and their modifications are so complicated, that it is next to impossible to properly separate them. By comparing the annexed Figures 46 *a*, *b* and *c*, with that of the true Army-worm moth (Fig. 47) the two insects will be found to differ widely.

[Fig. 46.]

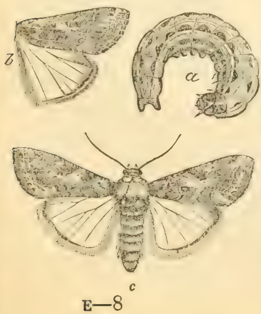


We have in this country a very common moth (*Prodenia commelinæ*, Abb.) which may be popularly called the Spiderwort Owlet moth, some of the varieties of which approach so nearly to some of the more strongly marked varieties of our Fall Army-worm moth that it is necessary to show the very great difference which really exists between them, in order that the cultivator may not be unnecessarily alarmed when he observes the former, by confounding it with the latter, and erroneously inferring that he will be overrun with Fall Army-worms when there is no real danger. The Spiderwort Owlet moth, (Fig. 48, *b* and *c*) is a handsomer and more distinctly marked species, the front wings inclining more to vinous-gray, or purplish-gray, and the ordinary lines being more clearly defined by very deep brown, than in the Fall Army-worm moth. But, however much these characters may vary—and they are quite variable—there are yet two others which will be readily noticed upon comparing the figures of the two species, and by which the Spiderwort moth may always

[Fig. 47.]



[Fig. 48.]



be distinguished from its close ally, namely, by the tip of the wing being more prolonged and acuminate, and by the three-forked nerve in the middle of the wing being much more conspicuous. Its larva never congregates in multitudes as does the Fall Army-worm, and differs so materially from that worm, and is withal so characteristically marked, that it may be recognized at once by the above illustration (Fig. 48, *a*). Contrary to what its name would indicate, it is a very general feeder, as I have found it on all sorts of succulent plants, both wild and cultivated, This insect is more or less numerous every year, but has never been known to multiply so prodigiously as the Fall Army-worm, which we have under consideration. It passes the winter either in the larva, pupa or perfect state, but more generally in the former.

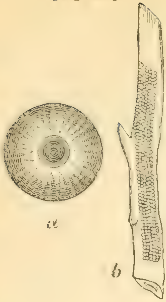
REMEDIES.

Now that I have sufficiently dwelt on the characteristics of the Fall Army-worm to enable any one to distinguish it, even from its nearest relative, let us consider for a moment what can be done to prevent its great injuries to grains and to vegetables. I have proved that there are at least two, and probably as many as three or even four broods during the course of the year; for those worms which appeared in such multitudes in August and the forepart of September, in due time produced moths, and these gave birth to a new generation of worms, which began to make their presence manifest towards the end of October. In 1868, also, I bred the moth as early as July, from worms received from Mr. Daggy. In this prolificacy the Fall Army-worm differs remarkably from the true Army-worm, as well as from most of its close allies, which generally produce but one, and seldom more than two, broods each year.

The moths were so numerous during the latter part of September and the forepart of October, that I not only found them common at Decatur, Vandalia and other parts of Central Illinois, and wherever I traveled in our own State, but I captured a goodly number in the very heart of St. Louis, and even caught some while riding by rail.

The eggs are deposited in small clusters, often in two or three layers one above the other, and the whole cluster is covered sparsely with the yellowish hairs from the ♀ abdomen. Each egg is nearly spherical, of a pale fulvous color, and differs only from that of the Unarmed Rustic (*Agrotis inermis,* Fig. 49, *a*, showing one magnified, and *b*, a batch of natural size,) in being less compressed and less distinctly ribbed. The clusters were found abundantly, not only on the under side of peach and apple leaves, which the worms readily devour, but on the leaves of such trees as sycamore, which, so far as we at present know, they do not feed upon. Under these last circumstances the young worms, upon hatching, would soon descend the tree to feed upon the more succulent herbage below; and the more I learn of the habits of our different Owlet moths,

[Fig. 49.]



a b

the more I become convinced that the long-accepted theory of their eggs being deposited on the ground is a false one, and that most of our cut-worms though fat, lazy and groveling in the ground when we find them, have been born in more elevated and exalted positions.

In the fall of 1868 this worm proved very destructive to the newly sown wheat in many parts of Franklin and St. Louis counties, Mo., and seemed to be confined to such wheat as was sown on oats stubble. I then accounted for this singular state of things by supposing that the scattering oats which were left after harvest had sprouted before the wheat, and had thus attracted the parent moths*; and, acting upon this supposition, I suggested that the attacks of the worm might effectually be prevented by plowing the land early and keeping the ground clear of all vegetation until the wheat was planted. This inference proves to be well warranted by the facts; and in future, when the Fall Army-worm is heard of during the months of August or September, as it was the present year, it will be wise for those who live in the immediate neighborhood, either to sow no fall grain at all or to endeavor, in doing so, to carry out the above suggestions. The last brood of worms, which at this writing (Nov. 7th) are not yet quite full grown, must evidently pass the winter in the ground, either in the larva or the pupa state. In either case a great many of them would be killed by late fall plowing which should be used, when practicable, as a remedial measure in fields where this insect has been numerous. When the worms are overrunning a field of fall grain, most of them could be destroyed by means of a heavy roller, without injury to the grain.

The question has been repeatedly asked: "Will this worm be as numerous next year as it has been this; or will it go on increasing in geometrical ratio, and be still more numerous?" Now, although I greatly dislike to weaken the confidence that some people seem to place in the oracular power of an entomologist to peer into the future, yet I must meekly confess my inability to give any definite answer to such questions.

Byron has truly said that, "the best of prophets of the future is the past;" and we may reasonably draw the inference that this worm will *not* be so abundant next year, because in the past it has only occasionally been so troublesome, and never, so far as the record shows, during two consecutive years. And we may rest tolerably well assured that it will not increase in geometrical ratio, because most vegetable feeding insects are preyed upon by more predaceous

*Report I, p. 88.

species and by parasites,* and because such continued increase of one species is inconsistent with the harmony we find everywhere in Nature. But we may not venture beyond the inference, as the happenings of the future are not for mortals to know. Some persons may also be curious to learn why this worm increases so much more in late summer and fall than in spring, since there are so many broods during the year; or why it is only noticed in certain years? Such questions, likewise, can receive no definite answer,

> "Till old experience do attain
> To something like prophetic strain."

For though, to meet the first, we may assume that the winter decimates their numbers, or that the spring weather is not favorable to their increase; and to meet the last we may conjure up a hundred reasons yet assuming is not knowing, and we must content ourselves with the facts as they occur.

In conclusion, it will afford a grain of comfort to those who have had wheat fields cleaned off by this worm, to know that their wheat is not necessarily ruined; for, as I personally ascertained, wheat that had been thus cut off in the fall of 1868 made a good stand the following spring; and in one instance, where part of a field had been invaded and the rest left untouched, it really appeared that the part which had been eaten off yielded the heaviest. Mr. Huron Burt, of Callaway county, Mo., also informs me that this insect always leaves blue-grass untouched.

PRODENIA AUTUMNALIS, Riley.—*Imago* (Fig. 46, *a, b* and *c*.)—*Front wings* narrow with the apex usually well rounded, and with the middle of the hind margin sometimes, but not often, extending beyond apex: general color mouse-gray variegated with smoky-brown, fulvous and pearly or bluish-white; apical patch bluish-white and never extending beyond nerve 5: the subterminal line—which is pale and bends like a bow, approaching nearest the terminal line between nerves 3 and 4—generally blends with this patch so as to appear to start from its lower edge, but is sometimes well separated from it so as to be traced further towards apex: dark space preceding subterminal line, confined between nerves 3 and 5, blending gradually with the rest of the wing, barely showing two darker sagittate spots: transverse anterior and transverse posterior either subobsolete or tolerably well defined, each by a geminate dark line: basal area divided longitudinally by an irregular dark line, the wing below it quite light-colored: orbicular spot large and elongated, a little lighter than surrounding surface, and well defined by a fulvous annulation, the pale oblique shade which generally encloses it in this genus confined to a fulvous shade above, and either a more distinct fulvous line behind or none at all: reniform spot generally dark, but sometimes lighter than space preceding; not well defined, the small pale spot at top being generally distinct, and either partaking of the same form, or resembling the small letter *c* [left wing]; the lower edge occupied by a distinct white dash, which however never extends beyond it and but seldom shows any tendency to furcate with the nerves: four tolerably distinct equidistant pale costal spots from reniform spot to apical patch: terminal line pale, even, parallel with posterior margin: terminal space dark, except near apex and anal angle, divided into subquadrate spots by the pale nerves: fringe either broad or narrow, of same color as wing, with a narrow darker inner line, relieved by two very fine paler ones which are barely distinguishable: under surface smoky, but paler inte-

* Many of the Fall Army-worms had the thoracic joints of the body more or less covered with the eggs of a *Tachina* fly, and I have bred from the worms the same parasite (*Exorista leucaniæ*, Kirk; 2d Rep. Fig. 17) which infests the true Army-worm, and still another allied species (*Tachina archippivora*) which infests the larvæ of the Archippus butterfly, and will be referred to on a future page.

riorly and terminally, and fulvous along costa; the whole with a nacreous lustre and more or less irrorate with brown, and often with a flesh-colored tint near apex; fringes dark. *Hind wings* white with a faint fulvous tint; semi-transparent and slightly irridescent, with extremities of nerves and borders, especially above, brown; fringes dusky, especially at apex, and with a paler inner line; under surface similar. Thorax, abdomen and legs of same general color as front wings, being paler below; the longer lateral and anal abdominal hairs more fulvous. Sexes with difficulty distinguished, the size and shape of the abdomen not even being a safe criterion. Maximum expanse 1.40; minimum expanse 1.05 inches. Described from 18 specimens, bred Sept. 20th—Oct. 10th, from corn-fed larvæ.

VARIETY FULVOSA, (Fig. 46, *b.*)—*Front wings* greatly suffused with fulvous, especially in the lower median space, which often inclines to ochraceous; apical space more or less defined; oblique median band distinct to median nerve, and orbicular spot with an ochre-colored centre. Described from 5 specimens, bred Sept. 25th—Oct. 3rd, from corn-fed larvæ.

VARIETY OBSCURA, (Fig. 46, *c.*)—*Front wings* of a much more uniform and darker color, either grayish-brown with a slight vinous tint, or deep smoky brown inclining to black, or a deep warm brown with but little gray; apical space either entirely obsolete or but very faintly indicated; oblique fulvous band across upper middle of wing also obsolete; the ordinary lines either entirely obsolete [one specimen only] or distinctly marked; the ordinary spots sometimes obsolete, but more generally indicated by fulvous lines. Described from 8 specimens, bred Sept. 21st—Oct. 2d, from corn-fed larvæ.

Larva, (Fig. 45, *a.*)—Ground-color very variable, generally dark and pitchy-black when young, but varying after the last moult from pale brown to pale dirty green, with more or less pink or yellow admixed—all the markings produced by fine, more or less intense, brown, crimson and yellow mottlings. Dorsum brownish with a narrow line down the middle, rendered conspicuous by a darker shade each side of it. A dark, subdorsal band one-third as wide as each joint is long; darkest at its upper edge, where it is bordered and distinctly separated from dorsum by a yellow line which, except on joint 11 where it deflects a little upwards, is quite straight; paler in the middle of each joint. A pale, either buff or flesh-colored, substigmatal band, bordered above and below by a narrow, yellow and wavy line. Venter pale. Head pale yellowish-brown, with sometimes a tinge of green or pink; the triangular piece yellowish, the Y-mark distinct and white, the cheeks with four more or less distinct lateral brown lines and with dark brown mottlings and nettings, which become confluent and form a dark curved mark at the submargin behind the prongs and each side of the stem of the Y. Stigmata large, brown, with a pale annulation, and just within the lower edge of the dark subdorsal band. Legs either light or dark. Cervical shield darker than body, with the narrow dorsal and subdorsal lines extending conspicuously through it: anal plate also dark, narrow and margined by the pale subdorsal lines—both plates furnishing stiff hairs, but without tubercles. Piliferous tubercles on joints 2 and 3, arranged in a transverse row, and quite large, especially on joint 2; on joints 4–10 inclusive the superior eight are arranged as follows: 4 in a trapezoid in dorsal space, the posterior two as far again from each other as the anterior two, and two near stigmata, one above and one behind; on joint 11 the dorsal 4 are in a square, and on joint 12 in a trapezoid, with the posterior and not the anterior ones nearest together: the thoracic joints have each a large subventral tubercle just above the legs. Length 1.10–1.50 inch. Described from numerons specimens.

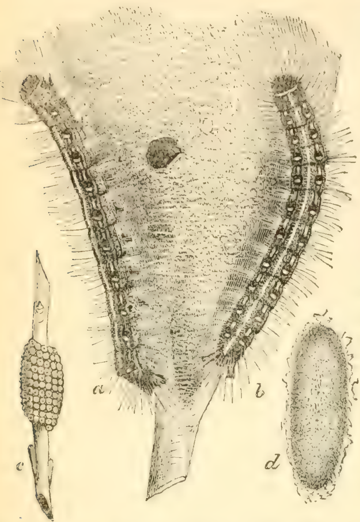
Pupa.—Formed in the ground, without cocoon; of normal form, bright mahogany-brown, and with a distinct forked point at extremity.

THE APPLE-TREE TENT-CATERPILLAR, OR AMERICAN LACKEY MOTH.—*Clisiocampa Americana*, Harr.

(Lepidoptera, Bombycidæ.)

What orchardist in the older States of the Union is not familiar with the white web-nests of this caterpillar? As they glisten in the rays of the spring sun, before the trees have put on their full summer dress, these nests, which are then small, speak volumes of the negligence and slovenliness of the owner of the orchard, and tell more

[Fig. 50.]



truly than almost anything else why it is that he fails and has bad luck with his apple crop. Wherever these nests abound one feels morally certain that the borers, the Codling-moth, and the many other enemies of the good old apple tree, mentioned in the beginning of this Report, have full play to do as they please, unmolested and unnoticed by him whom they are ruining; and when I pass through an orchard with two, three or more "tents" on every tree, I never pity the owner, because there is no insect more easily kept in check.

The small, bright and glistening web, if unmolested, is soon enlarged until it spreads over whole branches, and the caterpillars which were the architects, in time become moths, and lay their eggs for an increased supply of nests another year.

This insect is so well known throughout the country, and has been so well treated of by Harris and Fitch, that it is only necessary to give here the most prominent and important points in its history, the more especially as the figures alone which are given herewith will enable the novice to recognize it the moment it appears in a young orchard. Though some years quite abundant, it is not as common with us as in some of the Eastern States.

The eggs (Fig. 50, *c*) from which these caterpillars hatch are deposited mostly during the month of June, in oval rings, upon the smaller twigs, and this peculiar mode of deposition renders them conspicuous objects during the winter time, when by a little practice they can easily be distinguished from the buds, knots or swellings of the naked twigs. Each cluster consists of from two to three hundred eggs, and is covered and protected from the weather by a coating of glutinous matter, which dries into a sort of net-work. The little embryonic larvæ are fully formed in the egg by the commencement of winter, and the same temperature which causes the apple-buds to swell and burst, quickens the vital energies of these larvæ and causes them to eat their way out of their eggs. Very often they hatch during a prematurely warm spell and before there is any green leaf for them to feed upon, but they are so tough and hardy that they can fast for many days with impunity, and the glutinous substance on the outside of their eggs furnishes good sustenance and gives them strength at first. It is even asserted by Mr. H. C. Raymond, of Council Bluffs, Iowa, that the eggs often hatch in the fall and that in these cases the larvæ withstand the severity of the winter with impunity.

The young caterpillars commence spinning the moment they are born, and indeed they never move without extending their thread wherever they go. All the individuals hatched from the same batch of eggs work together in harmony, and each performs its share of building the common tent, under which they shelter when not feeding and during inclement weather. They usually feed twice each day, namely, once in the forenoon and once in the afternoon. After feeding for five or six weeks, during which time they change their skins four times, these caterpillars acquire their full growth, when they appear as at Figure 50 (*a* side view, *b* back view) the colors being black, white, blue and rufous or reddish. They then scatter in all directions in search of some cozy and sheltered nook, such as the crevice or angle of a fence, and having finally decided on the spot, each one spins an oblong-oval yellow cocoon (Fig. 50, *d*) the silk composing which is intermixed with a yellow fluid or paste, which dries into a powder looking something like sulphur. A few individuals almost always remain and spin up in the tent, and these cocoons will be found intermixed with the black excrement long after the old tent is deserted.

Within this cocoon the caterpillar soon assumes the chrysalis state, and from it, at the end of about three weeks, the perfect insect issues as a dull yellowish-brown or reddish-brown moth (Fig. 51), characterized chiefly by the front wings being divided into three nearly equal parts by two transverse whitish, or pale yellowish lines, and by the middle space between these lines being paler than in the rest of the wing in the males, though it is more often of the same color, or even darker in the females. The species is, however, very variable.*

[Fig, 51.]

The moths do not feed, and the sole aim of their lives seems to be the perpetuation of their kind; for as soon as they have paired and each female has carefully consigned her eggs to some twig, they die,

* Dr. Fitch, in the very excellent and detailed account of this insect in his second Report, shows how very variable the moth is, and from a large series of bred and captured specimens, I can fully corroborate the fact. I have specimens which are of an almost uniform pale tawny-yellow, while others are very dark, being what might be termed a bay-brown with the pale markings conspicuous, while others have a pale band across the hind wings so conspicuous as to very closely resemble the European *neustria*. Dr. Fitch in referring to his figures must certainly have made a mistake, for he calls Figure 4 the female and Figure 3 the male, while the reverse is apparent from the figures themselves. My own figure is intended to represent the female, but the middle space of the upper wings seldom if ever appears so light in this sex, as the engraver has erroneously represented.

and when the proper time comes around again the eggs will hatch, and the same cycle of changes takes place each year.

This insect in all probability extends wherever the wild black cherry (*Cerasus serotina*) is found, as it prefers this tree to all others; and this is probably the reason why the young so often hatch out before the apple buds burst, because, as is well known, the cherry leafs out much earlier. Besides the Cherry and Apple, both wild and cultivated, the Apple-tree Tent-caterpillar will feed upon Plum, Thorn, Rose and perhaps on most plants belonging to the Rose family, though the Peach is not congenial to it, and it never attacks the Pear, upon which, according to Dr. Trimble, it will starve. It does well on Willow and Poplar and even on White Oak, according to Fitch, who also found it on Witch Hazel (*Hamamelis*) and Beech.

REMEDIES.

Cut off and burn the egg-clusters during winter, and examine the trees carefully in the spring for the nests from such clusters that may have eluded the winter search. The eggs are best cut off in the manner presently to be described for the Tent-caterpillar of the Forest. Though to kill the caterpillars numerous methods have been resorted to, such as burning, and swabbing with oil, soap-suds, lye, etc., they are all unnecessary, for the nests should not be allowed to get large, and if taken when small are most easily and effectually destroyed by going over the orchard with the fruit-ladder, and by the use of gloved hands. As the caterpillars feed about twice each day, once in the forenoon and once in the afternoon, and as they are almost always in their nests till after 9 A. M., and late in the evening, the early and late hours of the day are the best in which to perform the operation. As a means of facilitating this operation, it would be a good plan, as Dr. Fitch has suggested, to plant a few wild cherry trees in the vicinity of the orchard, and as the moths will mostly be attracted to such trees to deposit their eggs, and as a hundred clusters on a single tree are destroyed more easily than if they were scattered over a hundred trees, these trees will well repay the trouble wherever the Tent-caterpillar is known to be a grievous pest.

The chrysalids of this caterpillar are often found filled with little maggots, which produce minute Chalcididan 4-winged flies of metallic green and black colors,* and belonging to the very same genus as the celebrated Hessian-fly parasite. This parasite, with other cannibal insects, and perhaps more or less favorable seasons, tend to produce a fluctuation in the numbers of these caterpillars, so that they are more numerous some years than others, and they were more numerous in 1868 than they have been since. It has also been noticed that dry summers are injurious to them. According to Dr. LeBaron,

* Described as *Cleonymus clisiocampæ* by Dr. Fitch (Rep., vol. I, p. 200), but subsequently more properly referred to the genus *Semiotellus* (Rep., Vol. III, p. 141.

the Baltimore Oriole occasionally pecks at the nests, but does not make a common article of diet of the caterpillars, and the only birds that devour them greedily are the American Cuckoos (*Coccyzus Americanus* and *erythrophthalmus*).

THE TENT-CATERPILLAR OF THE FOREST—*Clisiocampa sylvatica*, Harr.

(Lepidoptera, Bombycidæ.)

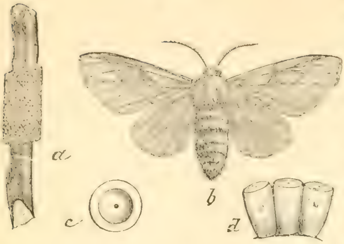
There is another insect which in all its stages so closely resembles the Apple-tree Tent-caterpillar as to be very generally confounded with it. This insect was first described by the great Massachusetts entomologist, Dr. Harris, and very appropriately named the Tent-Caterpillar of the Forest, the better to distinguish it from the other species which is more common in our orchards. He, however, unqualifiedly states that it lives in communities under a common web or tent; but with this exception gives a very clear and truthful account of it.* It has been quite destructive in many parts of Missouri during the past two summers, and as I have had good opportunities of studying its habits I shall endeavor to dispel the confusion and uncertainty about them which have hitherto existed in the minds of most of our farmers.

ITS NATURAL HISTORY.

The egg-mass from which the Tent-caterpillar of the Forest hatches (Fig. 52, *a*, showing it after the young larvæ have escaped) may at once be distinguished from that of the common Tent-caterpillar by its being of a uniform diameter, and docked off squarely at each end. It is usually composed of about 400 eggs, the number in five masses which I counted ranging from 380 to 416. Each of the eggs composing this mass is of a cream-white color, 0.04 inch long and 0.025 inch wide, narrow and rounded at the attached end or base, gradually enlarging towards the top, where it becomes slightly smaller (Fig. 52 *d*), and abruptly terminates with a prominent circular rim on the outside, and a sunken spot in the centre (*c*). These eggs are deposited in circles, the female moth stationing herself, for this purpose, in a transverse position across the twig. With abdomen curved she gradually moves as the deposition goes on, and when one circle is com-

* Inj. Ins. p. 376.

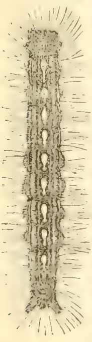
[Fig. 52.]



pleted, she commences another—and not before. With each egg is secreted a brown varnish which firmly fastens it to the twig and to its neighbor, and which, upon becoming dry, forms a carinated net-work of brown over the pale egg-shell. These eggs are so regularly laid and so closely glued to each other, and the sides are often so appressed, that the moth economizes space almost as effectually as does the Honey-bee in the formation of its hexagonal cells. In confinement the moth very seldom succeeds in forming a perfect ring, but in her abortive attempts, deposits them in different sized patches; and as I have found such unfinished patches attached to an oak leaf out-of-doors, we may conclude that either from injury or debility of some kind, the parent's instinct sometimes fails it even when all the conditions are normal and natural.

The eggs are deposited, in the latitude of St. Louis, during the latter part of June. The embryo develops during the hot summer weather, and the yet unborn larva is fully formed by the time winter comes on. The young hatch with the first warm weather in spring—generally from the middle to the last of March—and though the buds of their food-plant may not have opened at the time, and though it may freeze severely afterwards, yet these little creatures are wonderfully hardy, and can fast for three whole weeks, if need be, and withstand any amount of inclement weather. The very moment these little larvæ are born, they commence spinning a web wherever they go. At this time they are black with pale hairs, and are always found either huddled together or traveling in file along the silken paths which they form when in search of food. In about

[Fig. 53.]



two weeks from the time they commence feeding they go through their first moult, having first grown paler or of a light yellowish brown, with the extremities rather darker than the middle of the body, with the little warts which give rise to the hairs quite distinct, and a conspicuous dark interrupted line each side of the back. After the first moult, they are characterized principally by two pale yellowish subdorsal lines, which border what was before, the dark line above described. After the second moult, which takes place in about a week from the first, the characteristic pale spots on the back appear, the upper pale line becomes yellow, the lower one white, and the space between them bluish: indeed, the characters of the mature larva are from this period apparent. Very soon they undergo a third moult, after which the colors all become more distinct and fresh the head and anal plate have a soft bluish velvety appearance, and the hairs seem more dense. After undergoing a fourth moult without material change in appearance, they acquire their full growth in about six weeks from the time of first feeding. At this time they appear as at Figure 53, and for those who are interested in such matters, I quote below Dr. Fitch's description of the full-grown larva, as it is the first accurate and detailed description that was published, and as I have occasion to refer to it further on:

"The caterpillar, as seen after it has forsaken its nest and is wandering about, is an inch and a half long and 0.20 thick. It is cylindrical and of a pale blue color, tinged low down on each side with greenish gray, and is everywhere sprinkled over with black points and dots. Along its back is a row of ten or eleven oval or diamond-shaped white spots which are similarly sprinkled with black points and dots, and are placed one on the fore part of each segment. Behind each of these spots, is a much smaller white spot, occupying the middle of each segment. The intervening space is black, which color also forms a border surrounding each of the spots, and on each side is an elevated black dot from which arises usually four long black hairs. The hind part of each segment is occupied by three crinkled and more or less interrupted pale orange-yellow lines, which are edged with black. And on each side is a continuous and somewhat broader stripe of the same yellow color, similarly edged on each of its sides with black. Lower down upon each side is a paler yellow or cream-colored stripe, the edges of which are more jagged and irregular than those of the one above it, and this stripe also is bordered with black, broadly and unevenly on its upper side and very narrowly on its lower side. The back is clothed with numerous fine fox-colored hairs, and low down on each side are numerous coarser whitish ones. On the under side is a large oval black spot on each segment except the anterior ones. The legs and prolegs are black and clothed with short whitish hairs. The head is of a dark bluish color freckled with numerous black dots and clothed with short blackish and fox-colored hairs. The second segment* or neck is edged anteriorly with cream white, which color is more broad upon the sides. The third and fourth segments have each a large black spot on each side. The instant it is immersed in spirits the blue color of this caterpillar vanishes and it becomes black.

At this stage of its growth the Tent-caterpillar of the Forest may be seen wandering singly over different trees, along roads, on the tops of fences, etc., in search of a suitable place to form its cocoon. It usually contents itself with folding a leaf or drawing several together

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* It is necessary to remark here that in the above description, Dr. Fitch reckons the head as the first segment and the first leg-bearing segment of the body, which he calls the neck, as the second segment. If Lepidopterists could be induced to adopt some uniform rule in describing larvæ, it would prevent much confusion and error.

It is astonishing how loosely these segments are referred to by most authors. Thus Dr. Fitch, after calling the head the first segment in the above description, excludes it in the descriptions of the larvæ of *Dryocampa senatoria and Dryocampa stigma* which immediately follow (Reports 3, 4 and 5, §§ 322 and 323), and speaks of the long anterior horns as proceeding from the *second* segment, whereas, to be consistent, he should have made them proceed from the *third* segment, as Mr. Wm. Saunders has done with *Dryocampa rubicunda* (*Can. Entomologist* II, p. 76). Dr. Packard (Guide etc, p. 271) speaks of the caudal horn of the larvæ of *Sphingidæ* as proceeding from the *last* segment, which it certainly does not, whichever custom be adopted. Westwood (Intr., II,) though his language on page 319 would lead one to suppose that he included the head as the first segment, more often adopts the other rule, as for instance when he refers to the 11th segment in *Mamestra*, etc., (p. 344). Burmeister in his Manual of Entomology evidently excluded the head as a segment, for he refers (p. 35) to the "three first segments of the body following the head," and afterwards (p. 41) speaks in more precise terms of the body consisting of 12 segments.

Strictly speaking, the normal insect larva is composed of 13 segments, and a more or less distinct terminal sub-segment; but in all those larvæ in which the anterior segment is covered by a horny case, so as to form a distinct head, it seems more appropriate to consider this as the head in contradistinction to the twelve articulations of the body. Especially is this the case with Lepidopterous larvæ, which are so plainly marked with a horny head, 12 soft joints and a terminal sub-joint; and this plan has been adopted by most of the leading entomologists, including Boisduval, Guenée, Harris, etc.

In my own descriptions I have always adopted this course, so that when I speak of the first joint I mean that immediately following the head. Of late I have adopted the term *joint* because it is shorter and perhaps more strictly accurate than *segment*. I also discard the term *feet*, as often applied to the horny articulate legs, for they are not feet in any sense of the word, but are the true legs of the insect, and the simple term legs or thoracic legs will at once distinguish them from the abdominal an anal prolegs or false legs.

for this purpose, though it frequently spins up under fence boards and in other sheltered situations. The cocoon is very much like that of the common Tent-caterpillar, being formed of a loose exterior covering of white silk with the hairs of the larva interwoven, and by a more compact oval inner pod that is made stiff by the meshes being filled with a thin yellowish paste from the mouth of the larva, which paste, when dried, gives the cocoon the appearance of being dusted with powdered sulphur exactly as in that of the other species. Three days after the cocoon is completed the caterpillar casts its skin for the last time and becomes a chrysalis of a reddish brown color, slightly dusted with a pale powder, and densely clothed with short pale yellow hairs, which at the blunt and rounded extremity are somewhat larger and darker. In a couple of weeks more, or during the forepart of June, the moths commence to issue, and fly about at night. This moth (Fig. 52, *b* ♀) bears a considerable resemblance to that of the Common Tent-caterpillar (Fig. 51), being of a brownish-yellow or rusty-brown, and having two oblique transverse lines across the front wings. It differs, however, in the color being paler or more yellowish, especially on the thorax; in the space between the oblique line being, even in the males, usually darker instead of lighter than that on either side; but principally in the oblique lines themselves being always dark instead of light, and in a transverse shade, often quite distinct, across the hind wings. As in *Americana*, the male is smaller than the female, with the wings shorter and cut off more squarely. Considerable variation may be found in a given number of moths, but principally in the space between the oblique lines on the front wings being either of the same shade as the rest of the wing, or in its being much darker; but as I have found these variations in different individuals of the same brood, bred either from Oak, Hickory, Apple and Rose, they evidently have nothing to do with the food-plant. The scales on the wings are very loosely attached, and rub off so readily that good specimens of the moth are seldom captured at large. So much for the natural history of our Forest Tent-caterpillar.

THE LARVA SPINS A WEB.

From the very moment it is born till after the fourth or last moult, this caterpillar spins a web and lives more or less in company; but from the fact that this web is always attached close to the branches and trunks of the trees infested, it is often overlooked, and several writers have falsely declared that it does not spin. At each successive moult all the individuals of a batch collect and huddle together upon a common web for two or three days, and during these periods —though more active than most other caterpillars in this so-called sickness—they are quite sluggish. During the last or fourth moult they very frequently come low down on the trunk of the tree, and, as in the case of the gregarious larvæ of the Hand-maid Moth (*Datana* *ministra*), which often entirely denude our Black Walnuts, they unwittingly court destruction by collecting in such masses within man's reach.

IT FEEDS BOTH ON ORCHARD AND FOREST TREES.

In the summer of 1867 this insect did great damage in Western New York, where it is falsely called THE "Army-worm." From the fact that Mr. Peter Ferris, of Millville, Orleans county, N. Y., was greatly troubled with it that year in his apple orchard, and that he did not notice any of the same worms on the Oak and Walnut timber of that section, he concluded that his Apple-feeding worms must be different from those feeding on forest trees. In an article signed "F., Orleans county, N. Y.," which appeared in the *Country Gentleman* of July 23d, 1868, the same writer endeavors to prove his Apple-feeding worms distinct by sundry minute characters, as may be seen from the following extract:

Now I am not an entomologist, but still must be allowed to believe that there are several points, if not "distinctive characters," in which our caterpillar differs from the Tent-caterpillar of the Forest, as described by Dr. Fitch. His larva is of a pale blue color, tinged lower down on each side with greenish-gray. In ours the prevailing color on the back is black; there is a sky-blue stripe on each side but no greenish-gray. Both have the white spots on the back much alike, though perhaps ours are more club shaped, looking to the naked eye nearly the shape of ten-pins. Both have these spots surrounded with black; in ours there is quite a broad black stripe on each side of the spots. This black stripe is more or less filled with fine, crinkled, bright orange lines. In some, these orange lines are so plenty as to be seen plainly without the glass; in others the color to the naked eye is a fine velvet-black. In the larva described by Dr. Fitch there is much less of black and of the fine crinkled lines, which are pale orange-yellow. There is a somewhat broader stripe of the same yellow color, in place of a narrow orange one in ours. The lower yellow stripe may be much alike in both, but what is sky-blue in one is greenish-gray in the other. In both, the head is of a dark bluish color, but in his it is freckled with numerous black dots; in ours, both to the naked eye and under a glass, it is plain. In his "the second segment or neck is edged anteriorly with cream-white, which color is more broad on the sides. The third and fourth segments have each a large black spot on each side." Both the cream white edge and black spots are entirely wanting in our caterpillars.

The habits of the larvæ also appear to be different. According to Harris and Fitch, the Tent-caterpillar of the Forest lives in large societies, under a tent or cob-web-like nest placed against the side of the tree, and comes out to feed on the leaves. Others, as well as myself, have watched our caterpillars and entirely fail to discover that they lived in communities, or in any one place that they went from and returned to. While small, they remain scattered over the smaller branches and on the leaves, and are first seen to begin to get together when about half grown, on some of the higher limbs in the sun. They only collect in large bunches on the trunk and lower limbs; when nearly full grown, and the weather is hot, they get in the shade; and then they never have any web or particular place they return to, or show any uniformity in the size of the bunches. But they only manage in this way while the leaves last. As soon as one tree is stripped they go to another, and when one orchard is used up leave for another. They are great travelers; on a smooth track, like a hard road or a fence cap-board, they get along quite fast. They do not try to keep together, but each one goes on his own hook. There is very little said about the Tent-caterpillar of the Forest traveling in this way.

Then our larvæ appear decidedly to prefer the leaves of the Apple-tree, and only feed on the leaves of other trees when the former are not to be had. Though I am not prepared to say that they will not feed on Oak, Walnut or Hickory trees, under any circumstances, I have repeatedly found these trees in full leaf when not only Apple trees, but Ash and Basswood trees near by, were entirely stripped. The eggs are sometimes laid on Hard Maple shade trees, but the caterpillars leave these trees as soon as they get much size, evidently in search of food more suitable to their taste. This may be the case in regard to Oak and Walnut trees.

They also select different places for their cocoons. Dr. Fitch says the Tent-caterpillar of the Forest selects a sheltered spot for its cocoon, such as the corner or angle formed by the meeting of two or three sides. In this the cocoon is suspended. Our larva selects one or more leaves on any tree that is convenient. The edges of the leaves are drawn together, forming a shelter in which there is generally one cocoon; though when the space is large, and they are very numerous, there are often two or three cocoons together. The cocoon is not suspended, but fastened to the leaf. They spin their cocoons in the forepart of July, and the moths appear in the latter part of the month. The Tent-caterpillar of the Forest spins its cocoon about the 20th of June, and the moth appears in the forepart of July.

Now I think enough has been given to show that two distinct insects are under consideration, but, being only a farmer, I may be mistaken. I would like to see Dr. Fitch's views on this question. Undoubtedly he has read Dr. Walsh's article on "The Three so-called Army-worms," in the *Practical Entomologist*, and can tell whether our caterpillar is a distinct insect, or only shows the variations that may be expected in the Tent-caterpillar of the Forest.

Now since Dr. Fitch has not, to my knowledge, complied with Mr. Ferris's courteous wish, the labor has devolved upon me. I have taken upwards of 200 specimens from the same batch of Oak-feeding worms, and upon critically examining them, find that Dr. Fitch's description is accurate, and that the differences or variations mentioned by Mr. Ferris arise in every case, either from a misapprehension of Dr. Fitch's meaning, or from variations which may be found in the same brood. The only real difference between the two writers lies in the statement of Dr. Fitch that the worms live under a large cob-web-like nest, and that of Mr. Ferris that they do no such thing. Both statements should have been qualified, and were made without sufficient observation; for though the normal habit of the worms is to collect outside of their nests, I have seen exceptional instances of their collecting within or underneath it, especially when young.

Now it is just barely possible that in Western New York there may be a race of these worms that has taken to feeding on Apple and has lost all appetite or become incapacitated for feeding on forest trees; in other words, that there is a phytophagic variety, or a phytophagic species in process of formation. I could mention several similar occurrences among insects,* and to those who believe in the immutability of species these occurrences are incomprehensible enough; but to those who accept the more modern Darwinian views, and believe that species are slowly being formed to-day, just as they have been for long ages and ages in the past, they are most significant, and exactly what we should expect. But that such a race has yet been formed is rendered highly improbable from the following facts: 1st. It is spoken of both by Dr. Fitch and Dr. Harris as occurring on Oak, and by the latter as also occurring on Walnut, Apple and Cherry in the New England States. Mr. George E. Brackett of Belfast, Maine,† in referring to its ravages in the orchard, states that it also ravaged the forests in the summer of 1867, eating the leaves of most kinds of deciduous trees, though Poplar and Ash seemed to be their favorites. 2nd. I have, in our own State, successfully transferred them from Oak to Apple, and from Apple to Oak, and now have a suite of moths bred from larvæ which were fed half the time on the one and half the time on the other. Given an equal quantity of Oak, Apple, Plum, Peach, Cherry, Walnut, Hickory, Rose, they have invariably seemed to prefer and thrive best on the Apple.

IS IT EVER VERY DESTRUCTIVE?

This question is raised by Dr. Fitch, who, on insufficient grounds, discredited the previous assertion of Abbot, that it "is sometimes so plentiful in Virginia as to strip the oak trees bare." The destruction it caused in some of the Eastern States in 1866 and in 1867, is sufficient to decide this question; but there is every reason to believe that in the South and West its injuries are of still vaster extent. From Mr. John H. Evans of Des Arc, Ark., I learn that it last summer completely stripped the over-cup timber in the overflowed bottoms of that country, and for the past two years it has been quite destructive both to forest and orchard trees, in many parts of Missouri. In the Oak timber these worms prefer trees of the Black Oak group, and will seldom touch the White Oak in bodies, though when scattered among the other kinds, they attack it also.

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*For an account of such insects as are known to have phytophagic varieties or phytophagic species I must refer the reader to Mr. Walsh's papers on the subject in the proceedings of the Entomological Society of Philadelphia for 1864 and 1865. But, as the most familiar and striking examples I will mention, first—the polyphagous black-pencilled larva of *Halesidota tessellata*, Sm. and Abb., found feeding on Oak, Hickory, Elm, Plum and other trees, and the monophagous orange-pencilled larva of *H. Harrisii*, Walsh, found exclusively on Sycamore; the moths from the two being absolutely undistinguishable. Second—the yellow-necked larva of *Datana ministra*, Drury, found on Apple and other trees, and the black-necked larva of the same moth found on Black-walnut and Hickory. Third—the large Butternut and Walnut-feeding form of the common Plum Curculio (*Conotrachelus nenuphar*, Herbst.)

†Amer. Journal of Hort., Sept., 1867.

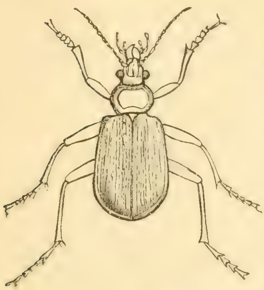
ARTIFICIAL REMEDIES.

From the time they are born till after the third moult these worms will drop and suspend themselves mid-air, if the branch upon which they are feeding be suddenly jarred. Therefore when they have been allowed to multiply in an orchard this habit will suggest various modes of destroying them. Again, as already stated, they can often be slaughtered *en masse* when collected on the trunks during the last moulting period. They will more generally be found on the leeward side of the tree if the wind has been blowing in the same direction for a few days. The cocoons may also be searched for, and many of the moths caught by attracting them towards the light. But pre-eminently the most effective artificial mode of preventing this insect's injuries is to search for and destroy the egg-masses in the winter time when the trees are leafless. Not only is this course the more efficient because it is more easily pursued, and nips the evil in the bud, but for the reason that, in destroying the eggs only, we in a great measure evade killing, and consequently co-operate with, the natural parasites presently to be mentioned, which infest the worms themselves. A pair of pruning shears attached to the end of a pole, and operated by a cord, will be found very useful in clipping off the eggs; or, as recommended by Mr. Ferris, a more simple instrument may be made by fastening a piece of an old scythe to a pole. If the scythe is kept sharp, the twigs may very handily be clipped with this instrument. Tarred bandages, or any of the many remedies used to prevent the female Canker worm from ascending trees, can only be useful with the Forest Tent-caterpillar when it is intended to temporarily protect an uninfested tree from the straggling worms which may travel from surrounding trees.

NATURAL REMEDIES.

It is always wise to co-operate, whenever we can, with our little friends among the Bugs, and it is consequently very necessary to be acquainted with them. It happens, fortunately, that we have several which aid us in keeping the Tent-caterpillar of the Forest in check, and in the natural forest we must trust entirely to these auxiliaries, as the mechanical means that can profitably be employed in a moderate sized orchard are impracticable in broad extents of timber. Indeed, these cannibals and parasites do their work so effectually that this caterpillar is seldom exceedingly numerous for more than two successive years in one locality, It prevails suddenly in great numbers, and again is scarcely noticed for years, very much as is the case with the true Army-worm. Thus, after attracting such general attention in 1867 in many parts of the East, it has scarcely been noticed since. This is its history everywhere, and we may reasonably hope that in those parts of the West where it has been cutting such a figure the present summer, it will suddenly be so subdued as not to be noticed for some years to come. Its undue increase but combines the assaults of its enemies, until they multiply so as to gain the ascendency. Then, from insufficiency of food these enemies suddenly decrease in numbers, and their natural prey has a chance to increase again. And so it goes on in the "Struggle for Life," and in the great complicated net-work in which every animal organism is involved: a check here and a check there, and no one of all the myriad forms allowed to keep the ascendency beyond a limited time. The most efficient cannibal insects in checking the increase of this Forest Caterpillar, are the larger Ground-beetles belonging to the genus *Colosoma.* These beetles will pounce upon the worms with astonishing greed, and are especially prone to attack them when helplessly collected together during the moulting periods. The Rummaging Ground-beetle (*Colosoma scrutator*, Fabr.), which every one will recognize from the figure (54), is especially fond of them. The most common parasite which occurs abundantly in the West, as well as in the East, and which I have bred from several other caterpillars, is a maggot producing a Tachina-fly, which differs only from the Red-tailed Tachina-fly (*Exorista leucaniæ*, Kirk.), which infests the Army-worm, in lacking the red tail.* The other parasite which infests it in the East, but which I have not yet met with, is a species of *Pimpla* very closely allied to *P. melanocephala*, Brullé, but differing from that species in the head being red and not black.†

[Fig. 54.]



SUMMARY.

The Tent caterpillar of the Forest differs from the common Orchard Tent-caterpillar principally in its egg-mass being docked off squarely instead of being rounded at each end; in its larva having a row of spots along the back instead of a continuous narrow line, and in its moth having the color between the oblique lines on the front wings as dark or else darker, instead of lighter than the rest of the wing. It feeds on a variety of both forest and orchard trees; makes a web which from its being usually fastened close to the tree is often overlooked; is often very destructive, and is most easily fought in the egg state.

**Exorista leucaniæ*, Kirkpatrick = *E. militaris*, Walsh. I have bred the variety lacking the red at tip of abdomen from larvæ of *Attacus cecropia*, Linn., *Datana ministra*, Drury, *Agrotis inermis*, Riley, and of two undetermined Agrotidians.

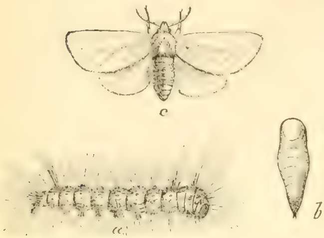
†*Practical Entomologist*, II, p. 114.

THE FALL WEB-WORM—*Hyphantria textor*, Harris.

(Lepidoptera, Arctiidæ.)

With the two preceding caterpillars is often confounded a third which in reality has nothing in common with them, except that it spins a web. The insect I refer to is known by the appropriate name of Fall Web-worm, and whenever we hear accounts of the Tent-caterpillars taking possession of trees and doing great injury in the fall of the year (and we do hear such accounts quite often), we may rest assured that the Fall Web-worm is the culprit and has been mistaken for the Tent-caterpillars, which never appear at that season of the year.

[Fig. 55.]



I do not know how injurious this insect is in the more Southern States, but he who travels in the fall of the year, with an eye to the beauties of the landscape, through any of the Northern and Middle States, especially towards the Atlantic sea-board, will find the beauty fearfully marred by the innumerable webs or nests of this worm. If they are as common as they were last fall, he will very naturally deplore the unsightly appearance of the forests, and feel amazed at the number of these signs of carelessness and slovenliness which occur in the cultivated orchards! The Web-worm is found on a great many kinds of trees, though on some more abundantly than others; but with the exception of the different grape-vines, the evergreens, the sumachs and the Ailanthus, scarcely any tree or shrub seems to come amiss to its voracious appetite. This insect passes the winter in the pupa state under ground and the moth emerges during the month of May or as late as the fore part of June. The female deposits her eggs in a cluster on a leaf, generally near the end of a branch, and these eggs hatch during the months of June, July and August, earlier or later, according to the latitude. Each worm begins spinning the moment it is born, and by their united effort they soon cover the leaf with a web, under which they feed in company, devouring only the pulpy portions of the leaf. As they increase in size they extend their web, but always remain and feed underneath it. When young the worms are pale-yellow with the hairs quite sparse and with two rows of black marks along the body and a black head. When full grown they generally appear pale-yellowish or greenish with a broad dusky stripe along the back and a yellow stripe along the sides, and they are covered with whitish hairs which spring from black and orange-yellow warts. Figure 55, *a*, gives a very good idea of a full grown worm, but the species is very variable both as to depth of coloring and markings.

Both Dr. Harris and Dr. Fitch state that this worm spins its thin cocoon in crevices of bark and similarly sheltered places above ground, but a great many of the specimens which I have reared (and I have bred specimens three different years) buried themselves and formed their cocoons just under the surface of the ground—thus giving evidence that the same insect will sometimes variously spin up above or below the ground. The chrysalis (Fig. 55, *b*) is of a very dark brown color, glabrous and polished and faintly punctured, and is characterized by swelling or bulging about the middle. The moth (Fig. 55, *c*) is white with a very slight fulvous shade: it has immaculate wings, but the front thighs are tawny-yellow and the feet blackish: in some the tawny thighs have a large black spot, while the shanks on the upper surface are rufous; in many all the thighs are tawny-yellow, while in others they have scarcely any color. One bred specimen in my cabinet even has two tolerably distinct spots on each front wing—one at base of fork on the costal nerve, and one just within the second furcation of the median nerve.

During the summer and fall of 1870 this worm was unprecedently numerous, not only in our own State but all over the country, and, as was remarked by others as well as myself, it hatched out much earlier than usual; for the first webs were noticed around St. Louis by the middle of June. It has always been supposed to be single-brooded, and in the New England States it never does perhaps produce more than one brood each year; but though such may be its normal habit, even in the latitude of St. Louis, yet there is good evidence that it sometimes produces two broods in that latitude, and in all probability does so constantly still further south. There appeared to be two broods with us the present year, and Mr. J. R. Muhleman, of Woodburn, Illinois, informed me that on August 5th, he had a second brood of worms, the first brood having appeared in June on Pear and Osage Orange. He did not, however, breed one generation from the other, and until this is done during the same year, we cannot say with absolute certainty that the species is two-brooded, for the disparity in time of appearance can be accounted for in other ways. The climate of the Central portion of our State is intermediate between that of the more Northern and the more Southern States, but the fauno partakes more of the character of the latter; and our summers are so variable in their duration and in their general intensity, that our insects show a great variability in their habits. It is for this reason that I find it very difficult to draw the rigid lines that many of our New England writers have done when treating of a particular insect, and it is for this reason that we frequently find insects, normally single-brooded there, often producing two broods a year here.

With us the Fall Web-worm appears to be most partial to the hickories and to the Black walnut, and least so to the oaks; but I have found scarcely any tree or shrub exempt from its attacks except those already mentioned, and it is even said to feed on the Hop-Plantain, Bean, Sunflower, and many other herbaceous plants.

From the foregoing account it will at once be seen how widely this Fall Web-worm really differs from the Tent-caterpillars. It hibernates in the pupa state, they in the egg state; it appears mostly in the fall, they mostly in the spring; its moth is pure white, theirs reddish brown; its eggs are deposited on a leaf, and hatch before the leaf falls, theirs are deposited around a twig, because they have to pass the winter and would get lost with the leaves if deposited upon them; it feeds solely on the parenchyma of the leaf under its web, they devour the whole leaf outside of their tent; and on account of these differences, we cannot employ the preventive measures against it which we take against them.

REMEDIES.

As, therefore, nothing can be done to materially affect this insect during the winter, we must do all the fighting when the worms first hatch. Their web soon betrays them, and the twig or branch containing it may be pruned off in the same manner described for the Tent-caterpillars. As the worms are always under the tent, the operation in this case can be performed at any time of the day without the risk of missing any wanderers.

HYPHANTRIA TEXTOR—*Larva*—(Fig. 55, *a*) Ground-color greenish-yellow. Dorsum velvety-black, with a narrow median pale line on thoracic joints. Sides speckled with black, except along subdorsal and stigmatal lines, where longitudinal yellow patches are left clear. Venter dusky or smoky-brown. Head shiny black with labrum and antennæ white. Thoracic legs black; prolegs long and narrow, smoky-black with faint orange extremities. Covered with long straight hairs, longest on joints 2, 3, 11 and 12. These hairs are either dirty white with a few black ones interspersed, or of a more uniform reddish-brown. They spring in bundles from around large warts situated as follows on each joint; 4 which are black and dorsal, arranged in a trapezoid, the anterior pair being the smaller; and four which are orange on each side, and arranged in a transverse row in the middle of the joint. Stigmata light yellow. Average length, 1.10 inches.

Varies considerably, in some the black predominating, in others the yellow. Those found on hickories are usually the darkest. When newly hatched it is pale yellow with two longitudinal rows of black marks and a black head.

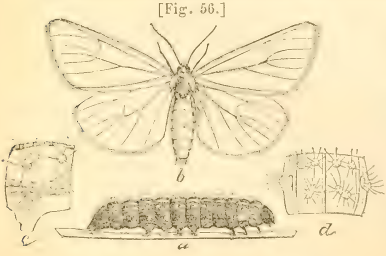
Described from numerous specimens.

THE BLUE-SPANGLED PEACH WORM—*Callimorpha fulvicosta*, Clem.

(Lepidoptera, Arctiidæ.)

In examining apple trees, but more especially peach trees, during winter or early spring, we often come across little black worms, covered with short, stiff, sprangling hairs, and studded with minute blue spots, sheltering under the loose bark. As soon as the leaves put out, these worms issue from their winter retreat and commence feeding. They

[Fig. 56.]



grow apace and by the end of April have usually acquired their full size, when they present the appearance of Figure 56, *a*; *c* showing an enlarged side section of one of the principal joints, and *d* a back view of the same. The color is now velvety black above, and pale bluish, speckled with black below; there is a deep orange line along the back, and a more distinct wavy and broken one along each side: the warts, illustrated in the enlarged sections are steel-blue and granulated, and their irregularities, as they catch and reflect the light, look like minute pale blue diamonds, the whole body, upon casually glancing at it, appearing studded with these blue points. This worm spins a slight cocoon of white silk in any sheltered place it can find, and changes to a chrysalis of a purple-brown color, finely and thinly punctured and terminating in a horizontally flattened plate, which is furnished with numerous yellowish-brown curled bristles. The moth (Fig. 56, *b*) issues from this chrysalis during the fore part of June. It is a very plainly marked species, being either milk-white or cream-colored, with the head, collar, basal and apical joints of the abdomen above, and the whole body, legs, and anterior margins of the wings fulvous or dull orange.* It was described in 1860 by Dr. Brackenridge Clemens under the name of *Hypercompa fulvicosta*† but is now properly referred to the genus *Callimorpha*. It may be known in English as the Cream Callimorpha as it is disguished from all other moths by its unspotted creamy appearance.‡ This worm is found more commonly on

Callimorpha vestalis, Packard (Proc. Ent. Soc. Phil. III, p. 108), must be considered as a synonym of *fulvicosta*, for Dr. Packard has certainly given no characters that should be considered specific. To show on what grounds the new species is founded I will quote in full the original description of *fulvicosta* and afterwards that of the so-called *vestalis*:

C. fulvicosta, Clem.—"White. Palpi yellow orange, tips blackish. Head prothorax, the anterior edge of the fore wings, especially beneath, yellow-orange; sometimes the costa of the fore wings is dark brownish. Breast and legs yellow orange, the middle and fore tibiæ and tarsi blackish. Abdomen tipped with yellowish orange.
"Illinois. From Robt. Kennicott."

C. vestalis, Pack.—"♂ and ♀ pure immaculate milk-white, ♀ white. Tips of the palpi brown. Head and prothorax, basal half of the patagia and costa of both wings above and beneath yellowish. The legs are also yellow beneath. The abdomen is white and unspotted. Antennæ brown. Body ♂ .65, ♀ .65. Exp. wings ♂ 1.70, ♀ 1.70 inch.
"Middle Atlantic States (Coll. Ent. Soc. Phil., through A. R. Grote."

Now, comparing the descriptions, *vestalis* differs in no other respect from *fulvicosta*, than in the legs being yellow beneath instead of having the middle and fore tibiæ blackish as described by Clemens. Three bred specimens in my possession differ in this trifling character, and though Dr. Packard says that his species differs *remarkably* [*!!*] from the other in being pure white and of smaller size, yet Dr. Clemens gives no measurements and there are specimens in my own cabinet and in Mr. Walsh's of all shades of white to cream color and some of them fully as small as the measurements above quoted. Moreover I have a specimen marked *vestalis*, kindly sent me by my friend Cresson of the Am. Entomological Society, and while in Philadelphia last fall I examined all the specimens marked or said to be *vestalis* without finding any distinguishing characters at all. If a new species is to be made out of such trifling characters in the face of the fact that the species of the genus *Callimorpha* are very prone to vary, and that twenty times as much variation is found in hundreds of other species of Lepidoptera, what is the science of entomology to come to?

†Proc. Acad. Nat. Sci. Phil., 1860, p. 536.

‡The only insect which very closely resembles it is a pale variety of a moth known as the Egle (*Euchætes egle*, Harr.) whose beautiful larva is tolerably common on our milkweeds. This last however may always be distinguished by the feathered antennæ of the male, the different shaped wings and the deep orange and black spotted abdomen.

the Peach than on any other tree, and as it appears very early in the season and commences to feed on the young leaves before they are fully expanded, it does considerable damage when numerous. I have been acquainted with the worm for several years past but its natural history was unknown till last summer when Dr. LeBaron and myself simultaneously bred the moth from peach-leaf feeding larvæ, so that its history is now given for the first time. Figures of the larva were given in the *Prairie Farmer* last summer by Dr. LeBaron who was misled by Dr. Hull into the belief that they were the Tent-caterpillar of the Forest already described. Two years ago I found this Blue-spangled worm tolerably common in the peach orchard of Mr. E. J. Ayres of Villa Ridge, Ills., and he says that he destroyed over a thousand of them last spring. In this State I have frequently met with it but it is by no means common. Hand picking will easily keep it in check.

CALLIMORPHA FULVICOSTA, Clem.—*Larva* (Fig. 56, *a*)—Color velvety-black above, pale bluish-gray speckled with black below. A deep orange medio-dorsal line (usually obsolete towards each end) and a more distinct, wavy, broken, yellow stigmatal line, with a less distinct coincident pale line below it. Covered with large highly polished, roughened, deep steel-blue warts, the irregularities of which as they catch and reflect the light, look like pale blue diamonds. Closely examined these warts are found to be covered with small elevations each of which furnishes a short stiff yellow hair, these hairs radiating in all directions around the warts, which are placed as follows:—Joint 1 with an anterior transverse row of 8 and a posterior dorsal row of 4; joints 2 and 3 each with a transverse row of 8 across the middle; joints 4—11 inclusive, each with 4 circular ones anteriorly, and 2 irregular ones posteriorly on dorsum (Fig. 56 *d*, each of the last evidently formed by the blending of two), and 2 on each side near the middle of joint (Fig. 56 *c*). Joint 12 with 2 that are irregular, on the back, and 1 that is circular, on each side. Anal shield formed of one large irregular wart. In addition to these there is a narrow subventral wart each side, and 2 small ventral ones on the legless joints. Head polished black with a few black hairs. Thoracic legs polished black, but pale at the joints inside: prolegs black outside, flesh-colored within and at extremities. Stigmata not perceptible. Largest in the middle of body. Average length 0.90, greatest diameter 0.15 inch.

Described from 6 peach-feeding specimens. Alcoholic specimens do not reflect the pale blue points.

The larvæ of our different *Callimorphas* seem to bear a very close resemblance to each other. I have bred *C. clymene*, Hubner, from a larva found full grown on oak (tho' whether it fed on oak I did not ascertain) which so resembled that of *fulvicosta* that I fully expected it would produce nothing else. The only difference noticeable was that it was very bright colored, with the medio-dorsal line very clear and distinct. Mr. Wm. Saunders has reared *C. LeContei* from larvæ feeding on Horse Gentian (*Triosteum perfoliatum*), and from his description of the larva* it differs principally from the above in lacking the blue reflections and in having a pale dotted subdorsal line.

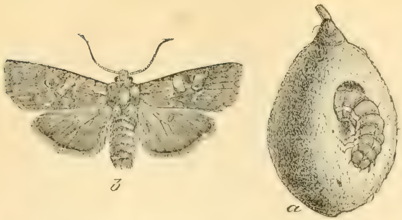
THE ASH-GRAY PINION—*Xylina cinerea*, N. sp.

(Lepidoptera, Xylinidæ).

There is a pale green worm with cream-colored spots and a broad cream-colored lateral band, which I have for several years known to

* *Canadian Entomologist* I, p. 20.

[Fig. 57.]



be common on the Apple, Poplar, Hickory and some other trees, the leaves of which it devours, but which last summer attracted unusual attention by its being frequently found boring into apples and peaches, and as I also commonly found it hiding in and feeding upon one of our large oak-apples (the *spongifica*) we may conclude that it is a very general feeder and that it is fond of boring.

This worm (Fig. 57, *a*) is found during the months of May and June and when full grown burrows beneath the surface of the ground where it forms a very thin cocoon of filmy silk with the earth adhering to it on the outside. It changes to a mahogony-brown chrysalis and generally issues as a moth during the September or October following, though in northern Illinois I have known it to remain in the chrysalis state through the winter and not issue as a moth till April.

The moth (Fig 57, *a*) varies considerably in its appearance, but is characterized by the cold ash-gray appearance of the front wings which are variegated with darker gray as in the figure. It is an undescribed species and belongs to a genus (*Xylina*) which is easily recognized by the long narrow almost rectangular wings, the very square thorax which is often furnished behind the collar with a bifid crest, and the rectangular and flattened abdomen. The wings are folded in repose and appear almost parallel and like a flattened roof—giving the insect an elongate appearance.

XYLINA CINEREA, N. Sp.—*Larva* (Fig. 57, *a*.) Length when full grown 1.20—1.30 inches, color shiny silvery-green on the back, darker below. A medio-dorsal cream-colored stripe ; a subdorsal one represented by 3 or 4 irregularly shaped spots on each joint. A broad deep cream-colored stigmatal line, with a few green dints in it, extending to anal prolegs. Four slightly elevated cream-colored spots, encircled by a ring of rather darker green than the body, in the dorsal space, and in the subdorsal space there are four or more similar but smaller spots. Venter glaucous-gray. Head as large as joint 1, free, glassy-green with white mottlings at sides and top, and pearly-white lips. Thoracic legs whitish. Prolegs concolorous with venter. When young the body is darker and the markings paler.—Described from two living specimens.

Imago (Fig. 57, *b*)—*Front wings*, with the ground-color pale cinereous shaded and marked either with light brown, having a faint purplish tint, or with darker brown, having a similar reflection, or with a colder grayish-brown with the faintest moss-green reflection : in the first two cases the dark color either blends and suffuses with the ground-color so as to give the wing a nearly uniform and smooth appearance, or else contrasts sufficiently to bring out all the marks distinct; in the latter case (two specimens) the markings are very distinct and the ground color is whiter and more irrorate. In the well marked specimens the usual lines are readily distinguished, the basal half line, transverse anterior and transverse posterior being quite wavy, pale, and bordered each side with a dark shade, the median shade dark and well defined and the subterminal line, though sometimes pale near costa, forming a series of dark angular spots : in the more uniform specimens these lines are barely distinguishable and perhaps the most constant is the sub terminal which most often takes the form of a series of dark angular spots : the ordinary spots have a pale inner and a more or less distinct dark outer annulation ; the orbicular is larger than the reniform and is sufficiently double to take on the form of an 8, the upper part of which is always largest and with the interior space paler than the general surface, while that of the lower part is either concolorous or darker; the form is, however, quite irregular and differs sometimes in the two wings of the same species: the reniform spot is generally well defined, and is either darker, or has a tinge of reddish-brown, interiorly: at the base of the wing is a more or less distinct pale space occupying the upper half, and bordered below by a brown line which is straight about half its length and then extends upwards and outwards towards transverse anterior. A tolerably distinct terminal line, with the fringes dark. In taking a general view of the varying specimens this pale basal space, the pale upper part of the orbicular and the dark subterminal line, seem to be the most constant characters of the species. *Hind wings* gray-brown inclining to cinnamon-brown, with the posterior border but slightly darker and the fringe paler. Under surface quite uniform, that of front wings being nacreous gray with a faint discal spot and with a narrow costal and broad terminal border of pale fulvous, dusted with purple-gray; the hind wings of this last color with the lunule and line distinct. *Head* nearly entire, though the quadrifid arrangement of the hairs is traceable; palpi hairy throughout. *Thorax* quite square, of same color as primaries and with the collar bordered behind with brown and sometimes the edges of the tegulæ similarly bordered. *Abdomen* of same color as hind wings with lateral tufts, and cut off squarely at apex. Expanse 1.32—1.82 inches.

Described from 3 specimens fed on grape-vine, 2 on peaches and 1 on *Cercis canadensis*. Other captured specimens examined.

This species is the analogue of, and very closely resembles the European *Xylina conformis*, which is known under various synonyms. A specimen sent to Mr. P. C. Zeller of Stettin, Prussia, was, however, pronounced distinct. The well-marked irrorate form still more closely resembles Guenée's *cinerosa* found in Switzerland, and which he himself thinks may prove to be a variety of *conformis*. The more I study the species of the NOCTUIDÆ as they occur in nature, the more I am struck with their great variability, and there can be no doubt that many of the so-called species will turn out to be but varieties when we better understand them. In this large family none but the more strikingly marked species should ever be described without an accompanying description of their preparatory states and of their principal variations. I am unacquainted with any of Walker's species except *subcostalis* which is very different, and if this should prove to be a synonym of any of them, the fault must be laid to the difficulty under which the naturalist in the Western States labors for want of proper libraries to refer to. It differs essentially from Grote's *Bethunei* and *capax* as described and illustrated in Volume I of the Transactions of the American Entomological Society. I am informed by Mr. A. Lintner of Albany, N. Y., that Dr. A. Speyer of Rhoden, Furtsenthum Walldeck, Prussia, who gives much attention to the Noctuidæ, has it marked *Celæna oblonga* in his MS., but the insect evidently does not belong to that genus, and as the German pronunciation of *Xylina* much resembles the English pronunciation of *Celæna*, the reference to the latter, is doubtless due to a verbal misunderstanding.

BENEFICIAL INSECTS.

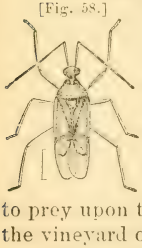
It is not often that there will be much to say in this Department, as most of the beneficial insects are treated of in connection with the injurious species upon which they prey. But the following little fellow is so important to the grape-grower that it should be recognized by every vineyardist in the State, and cherished as the very apple of his eye:

THE GLASSY-WINGED SOLDIER-BUG—*Campyloneura vitripennis,* Say.

A NEW FRIEND TO THE GRAPE-GROWER.

This is the bug; and a pretty little thing it is too! Take a good look at the figure and remember that the hair-line at the side represents the natural size.

[Fig. 58.]

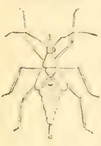


There are perhaps no insects more dreaded by the grape-grower than the different species of leaf-hoppers which sap up the substance of the leaves of the Vine; but as they will be treated of, in all probability, in my next Report, we will pass them over for the present.

No parasitic or cannibal insect has ever been known to prey upon these leaf-hoppers before, but last September, while in the vineyard of Dr. C. W. Spaulding, at Rose Hill, on the Pacific railroad, I discovered that this Glassy-winged Soldier-bug was preying upon them. The leaves were actually covered on the underside with the dead carcasses of the leaf-hoppers, which, in their death-struggle, had firmly attached themselves, and hung thickly, with wings extended and body sucked dry—dead proof of the surprising thoroughness with which their mortal foe had done its work of slaughter. On a single leaf not so large as a man's hand a half hundred of these skeleton leaf-hoppers could be counted, and though this number was above the average, there were few leaves that did not show quite a number. To use Dr. Spaulding's language, "the sight was enough to gladden the heart of any grape-grower, who had long looked upon the leaf-hopper as a permanent evil against which he could not successfully contend."

Moving about among the leaves our little Soldier-bug* was often seen in its pretty full dress uniform, but far more commonly disguised in its larval or pupal coat; for it is only when full grown and full fledged that it presents the appearance of the first figure. The larva and pupa both have an opaque, mealy, bluish-white appearance, and the

[Fig. 59.]



latter differs only from the former in the more conspicuous wing stubs, which project so as to give it a somewhat diamond shaped outline (Fig. 59.) It is during these immature, and less conspicuous stages that this insect doubtless does most of its work, for in common with the rest of the true Bugs (*Heteroptera*) it is active and feeds during its whole life, from the time it hatches from the egg till it dies of old age.

When I first saw the hosts of leaf-hoppers so mercilessly stabbed, I was at considerable loss to understand what animal could be so wary and dexterous as to surprise insects so shy and active, and with such wonderful jumping powers as the leaf-hoppers possess, and I could not rest sure that it was our little Glassy-winged Soldier-bug till I had enclosed specimens in a bottle with living leaf-hoppers, and found the latter dead next day. Like many other animals of prey, it can move actively when necessary, but no doubt prefers to surprise its victims by stealth, assisted perhaps by its colors which resemble those of the leaf-hoppers themselves.

The more common color of this insect is pale greenish-yellow. The antennæ are brown with the basal joint and sometimes part of the second joint blood-red. The head and thorax are pale yellow with a slight tinge of pink, and the eyes, neck, and front part of the thorax, except a pale line on the back, are jet black in high contrast. The scutel is pale yellow or white, and black at base, and the upper wings (hemelytra) are beautifully transparent with a rose-colored cross band and a dusky curved line. The species is a very variable one, however, being dichromous or double-colored, some varieties possessing much more brown than others, and having no rose-color at all. In a variety kindly sent me by Mr. P. R. Uhler, of Baltimore, Maryland, the antennæ are pale, and there is no black on the thorax in front, but a large brown patch behind; there is also a large brown patch each side of the scutel, and the rosy transverse band on the wings is quite brown.

Now this insect is commonly found by collectors in the fall of the year on different kinds of Oak, but no one ever heard before of its

I have preferred to apply this popular term to this species, because its black, white and red marks, and its war-like propensities suggest something of the sort; and though the term is more strictly and correctly applied to larger cannibal bugs belonging to the genus *Arma*, yet it is not inappropriate here, and will appeal to the popular mind far more readily than the generic name *Campyloneura*, or the English rendition of it, curved-nerve.

attacking the leaf-hoppers of the Grape-vine, and it certainly could not have done so in past years to the extent that it did at Rose Hill last fall, without its work having been noticed. I have been through vineyards by the hundred in the fall of the year, and never before noticed such work. How are we then to account for its sudden appearance in such force in the vineyard of Dr. Spaulding? To my mind it is an excellent illustration of an insect acquiring a new habit. Some individual or individuals wandering from the oaks and from whatever food they there subsisted upon, came upon Dr. Spaulding's vineyard and found the leaf-hoppers of the Vine to their taste. Their food being abundant, they soon multiplied, so as to make their work appreciable, and commenced to spread from one vineyard to another. The facts in the case would support such a theory, for the bugs and their slaughtered victims were found in diminishing numbers in the vineyards in the immediate neighborhood until at the distance of three miles, no sign of either could be found. Consequently, though our little cannibal friend occurs sparingly throughout the country in the native timber, it is found in the cultivated vineyard in a limited district only, so far as we now know. But there is no reason why the field of its operations in the vineyard should not in time become co-extensive with that of the troublesome leaf-hoppers; and with our present mail facilities we can materially help to make it so by artificially introducing a few dozen of the living bugs from one vineyard to another.

This species was first described by Say as *Capsus vitripennis*. The *Phytocoridæ*, as the name indicates, have all been hitherto considered as plant-feeders, and at first the species above considered would appear to be an exception to the unity of habit in the family. But Mr. Uhler informs me that his investigations of the elongated forms of many of the recently established genera have taught him that the affinities of many of them are largely with the *Reduviidæ* through *Anthocoridæ*; for he has often found them in places where small caterpillars were numerous; among the larvæ of *Tingidæ*, and has even caught them in the act of sucking the juices of plant-lice.

INNOXIOUS INSECTS.

THE WHITE-LINED MORNING SPHINX—*Deilephila lineata*, Fabr.

(Lepidoptera, Sphingidæ.)

[Fig. 60.]

The beautiful moth which heads this chapter is quite common in the State of Missouri, and has upon several occasions been sent to me for identification. Almost every one must have been struck with the great resemblance which it bears to a humming bird, as, of a summer's evening, it flits rapidly from plant to plant in the garden, and ever and anon hovers noiselessly over some particular flower, and stretches forth its long tongue to sip the sweet nectar which that flower contains.

Few persons are, however, aware what this beautiful moth looks like, or what it feeds upon, in the caterpillar state; wherefore this brief account of it.

The very great diversity of form and habits to be found amongst the larvæ of our butterflies and moths, has much to do with the interest which attaches to the study of these masked forms. I am moved to admiration and wonder as thoroughly to-day as in early boyhood, every time I contemplate that within each of these varied and fantastic caterpillars—these creeping and groveling "worms"—is locked up the future butterfly, or moth, which is destined, fairy-like, to ride the air on its gauzy wings, so totally unlike its former self. Verily the metamorphoses of the lower animals must prove a never-failing source of joy and felicity to those who have learned to open the pages of the great Book of Nature!

But beyond the general satisfaction experienced in studying these transient forms, there will be found ample food for the philosophic mind in the larval variations to be met with in the same species. Some vary according to the character of their food-plant, and the study of these variations—of phytophagic varieties and phytophagic species—must ever prove interesting as well as important, by throwing light on the question of the origin of species. Some (*e. g.* the common Yellow Bear, Fig. 28, *a*, p. 68) vary very much without regard to food-plant. Our Sphinx larvæ, more particularly, are subject to these variations, and it is for this reason that larval characters alone, unaccompanied by those of the perfect insect, are of so little value in classification.

The White-lined Morning Sphinx (Fig. 60) presents one of the most striking cases of larval variation, as may be seen by comparing the light form of Figure 61 with the dark form of Figure 62. In the summer of 1863 I took both these forms on the same plant, and have repeatedly met with them since; but the moths bred from them show no differences whatever.

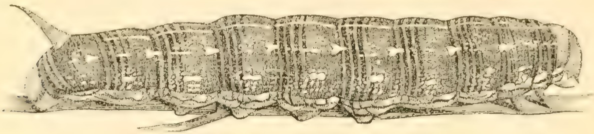
This beautiful moth is called by Harris the White-lined Morning Sphinx, though its generic name means "Evening Friend." It is distinguished principally by its roseate under-wings, and by a broad, pale band running from the apex to the base of the dark-olive front wings.

[Fig. 61.]

The larva feeds upon purslane, turnip, buckwheat, watermelon, and even apple and grape leaves, upon any of which it may be found in the month of July. It descends into the ground and, within a smooth cavity, changes into a light brown chrysalis, from which the moth emerges during the month of September.

The most common form of this larva is that given at Figure 61; its color is yellowish-green, with a prominent subdorsal row of elliptical spots, each spot consisting of two curved black lines, inclosing superiorly a bright crimson space, and inferiorly a pale yellow line—the whole row of spots connected by a pale yellow stripe, edged above with black. In some specimens these eye-like spots are disconnected, and the space between the black crescents is of a uniform cream-yellow. The breathing-holes are either surrounded with black, or with black edged with yellow. The other form is black, and characterized chiefly by a yellow line along the back, and a series of pale yellow spots and darker yellow dots, as represented in the illustra-

[Fig. 62.]



tion (Fig. 62). Even this dark form is subject to great variation, some specimens entirely lacking the line along the back, and having the spots of different shape.

This insect has a wide range, as it occurs in the West Indies, Mexico and Canada, as well as throughout the United States. Feeding, as it does, principally on plants of but little value, and being very commonly attacked by the larva of a Tachina-fly, this insect has never become sufficiently common to be classed as injurious. The Tachina-fly which so commonly infests it, is readily distinguished from the other more common form by the abdomen, which is bright rufous with the exception of a broad dorsal stripe which is dark.

TWO OF OUR COMMON BUTTERFLIES.

THEIR NATURAL HISTORY; WITH SOME GENERAL REMARKS ON TRANSFORMATION AND PROTECTIVE IMITATION AS ILLUSTRATED BY THEM.

In the following pages I propose to give the complete natural history of two of our commonest butterflies, and to close with such philosophical thoughts as the subject warrants. I do so the more willingly as many of the facts are published for the first time; for notwithstanding the butterflies are so common, their complete natural history has hitherto been unknown.

THE ARCHIPPUS BUTTERFLY—*Danais archippus*,* Fabr.

(Lepidoptera, Danaidæ.)

ITS NATURAL HISTORY.

[Fig. 63.]

"What more felicitie can fall to creature
Than to enjoy delight with libertie,
And to be lord of all the workes of Nature,
To raine in th' aire from earth to highest skie,
To feed on flowres and weeds of glorious feature."
The Fate of the Butterfly—Spenser.

This beautiful butterfly, like most of the species of the family to which it belongs, enjoys a wide range, occurring in the more northern of the States and in Upper Canada and extending into South America, where, according to Mr. Bates, it is common throughout the region of the Lower Amazons.† In the Mississippi Valley it is one of our most common species. The family to which it belongs is distinguished by the front legs being spurious or abortive; by the large cell in the centre of each wing being closed, and by the existence of a small nervule originating at the base of the front wing just below the lower or sub-median nerve, and joining that nerve a short distance from its base.‡ This nervule is so covered with scales that it is hardly visible till they are removed. In the genus *Danais* the sexes are readily distinguished by the male having a small horny

* Some late writers use the specific name *erippus* of Cramer, because it seems to have the priority. I have not all the works of the old authors to refer to, but Mr. Sanborn, of Boston, has been kind enough to refer to them for me, and he writes that *erippus* was first applied by Cramer to the ♀ in 1775, and *plexippus* to the ♂ by the same author in 1780. Fabricius published his name of *archippus* in 1793, and the name had already been applied by Cramer to the Disippus butterfly. Accordingly Cramer's *erippus* has the priority; but as this insect has been very generally known by the name which Fabricius gave it, among entomological writers, and as it has become familiar to the popular ear, I prefer to retain it—especially since it is no longer applied to the Disippus butterfly.

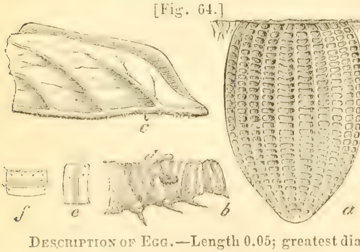
†Trans. Linnæan Soc., Vol. XXIII, p. 516.

‡Mr. Bates in a note to the paper already referred to, (p. 497,) gives this as a constant and excellent character discovered by Dr. C. Felder, of Vienna, and describes it as "a small nervule at the base of the fore-wing median nervure which anastomoses with the median a short distance from its origin." I have no means of referring to Dr. Felder's original article, and cannot say whether he is correctly quoted; but in the two N. A. species of the genus (*D. archippus* and *berenice*) this nervule originates below and anastomoses with sub-median nerve.

excrescence near the disk of the hind wing, close to, or upon the fourth nerve. This excrescence or tubercle is faintly shown in the above figure, which represents the male, and it is entirely lacking in the female. The color of the Archippus butterfly is of a bright orange-red, marked with black and cream-color as in the figure—the underside being similarly marked but paler, that of the hind wings being bright fulvous. The species feeds upon most of the different kinds of Milk-weed or Silk-weed (*Asclepias*), and also upon Dogbane (*Apocynum*), according to some authors. It shows a wonderful dislike, however, to the Poke Milk-weed (*Asclepias phytolaccoides*), and I was surprised to find that larvæ furnished with this plant would wander about their breeding cages day after day, and would eventually die rather than touch it, though they would eagerly commence devouring the leaves of either *A. tuberosa*, *curassavica*, *cornuti* or *purpurascens* as soon as offered to them.

The butterflies hibernate, though whether any but the impregnated females survive until the Milk-weeds commence to grow is not definitely ascertained. They commence depositing eggs in the latitude of St. Louis during the fore part of May. Some of the earliest developed butterflies from these eggs begin to appear about the middle of June and others continue to appear for several weeks. These lay eggs again, and the butterflies abound a second time in October. Thus there are two broods each year, and though the first brood of larvæ are hatched more uniformly and within a more limited time than the second, the two broods yet connect by late individuals of the first and early individuals of the second, and the caterpillars may be found at almost any time from May to October, but are especially abundant during late summer and early fall.

[Fig. 64.]



The egg (Fig. 64, *a*, magnified; *c*, natural size) is invariably deposited on the under side of a leaf, and is conical and delicately reticulate with longitudinal ribs, and fine transverse striæ. It is yellowish when first deposited but becomes gray as the embryo within develops.

DESCRIPTION OF EGG.—Length 0.05; greatest diameter 0.03 inches. Conical, slightly narrower at base than in middle, and generally slightly contracted towards apex. Color pale cream-yellow; opaque, smooth; the shell but slightly polished and rather soft. About 22 longitudinal narrow carinate ribs, usually regular and single, though occasionally one gives forth a branch; interstices crossed by about 30 very fine transverse striæ, often subobsolete. Apex smooth. Slightly and singly attached to the underside of leaf.

Described from numerous specimens.

It is a little singular that this egg has not previously been described. It is very easily found, and I had no difficulty in obtaining great numbers last summer, though I owe the first one ever obtained to the sharp eyes of Miss M. E. Murtfeldt, of Kirkwood, a lady who takes much interest in Entomology, and is an excellent observer. It were greatly to be wished that more of our ladies would interest themselves in such studies, for we have altogether too few Madam Merians.

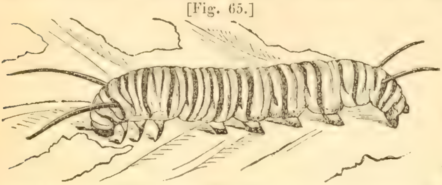
In about five days after deposition, the egg hatches, and the young larva as soon as hatched usually turns round and devours its egg-shell; a custom very prevalent with young caterpillars. At this stage it differs considerably from the mature larva; it is perfectly cylindrical, about 0.12 inch long and much of a thickness throughout. The head is jet black and polished; the color of the body is pale greenish-white with the anterior and posterior horns showing as mere black conical points, and with two transverse-oval black warts, nearer together, on the first joint. It is covered with minute black bristles, arising from still more minute warts, six on the back and placed four in a row on the anterior portion and one each side on the posterior portion of each joint, (Fig. 64, *f*); and three on each side, one in the middle of the joint, and two which are substigmatal, posteriorly, (Fig. 64, *e*.) There is a sub-triangular black spot on the anal flap, the legs are alternately black and white and the stigmata are made plainly visible by a pale shade surrounding them. When the young worm is three or four days old, a dusky band appears across the middle of each joint; and by the fifth or sixth day it spins a carpet of silk upon the leaf, and prepares for its first moult. After the first moult the anterior horns are as long as the thoracic legs, the posterior ones being somewhat shorter; the characteristic black stripes show quite distinctly, but the white and yellow stripes more faintly. After this it undergoes but slight change in appearance, except that the colors become brighter and that at each successive moult the horns become relatively longer. There are but three moults.* and the intervals between them are short, as the worms frequently acquire their full growth within three weeks from hatching.

Some persons may be curious to know how the larva acquires longer horns at each moult. The explanation is simple. During each period of growth the skin which is to serve for the next period is forming and perfecting under that which at the the time serves the worm. Upon this inner skin and beneath the outer one, the horns are also developing, and when the outer skin has become useless and the worm, after a short period of rest and fasting, bursts it near the head and works it off, the old horns go with the old skin and the new ones appear as mere stubs. The new skin is now very fresh and moist, and no sooner is the old skin off than these soft stubs begin to swell, and it is then easily seen how wonderfully the long horns

*I do not include the last moult by which the larva is transformed to the chrysalis. Some persons in counting the different moults that larvæ pass through, are content with counting the heads that are shed. Whenever this method is relied on it should be borne in mind that the heads really increase in size between each moult, though not in proportion to the increase of body. Thus, in the present species the first head is considerably larger when shed than it was when the larva hatched, and though appearing uniformly black when hatched, it shows the usual white marks more or less distinctly when shed.

have been folded up and curled over and between the wrinkles of the body so as not to impede the casting of the skin. At Figure 64, *b*, I have given a somewhat enlarged view of a worm just in the act of casting its last skin in order to show (at *d*) how the flexible horns were folded. They unbend of their own accord, though the worm often helps to straighten them out by cunningly turning its head and drawing them over the surface of the leaf.

[Fig. 65.]

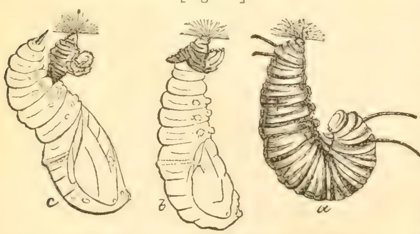


When full grown the worm presents the appearance of Figure 65, the colors being black, white and yellow.

HOW THE LARVA BECOMES A CHRYSALIS.

The metamorphoses of insects will ever prove a source of wonder and admiration. If a naturalist were to announce to the world the discovery of an animal which, for a short term of its life, existed in the form of a serpent; which then, after performing its own interment and weaving itself a shroud of pure silk, changed to something like an Egyptian mummy; and which after remaining thus buried without food or motion, for a much longer term, should at length struggle through its shroud and start into day a winged bird—every one would be interested in the history of such a marvelous creature! Yet the transformation of insects are scarcely less startling than such an occurrence would be, and it is only by drawing such a picture, that we are made to fully appreciate these changes. The methods of transformation are varied, as the reader who has perused these Reports is well aware. A good illustration is often needed in our schools, and as the present species furnishes an excellent illustration of the process in those butterflies which are suspended in the chrysalis state from the tail, and is withal so common that those who desire to witness the process will have no difficulty in doing so, I will give some account of it; for the person who had never witnessed the true method employed, might gaze a long time at the full grown larva (Fig. 65,) and the chrysalis (Fig. 67) without divining how the latter was produced by the former. We have on the one hand a crawling worm, and on the other a legless body hanging securely by

[Fig. 66.]*



*These figures are drawn from memory and are perhaps a little ideal and inaccurate.

its tail. What has become of the larval appurtenances and how did the chrysalis attach itself? Let us see.

As soon as the larva is full grown it spins a little tuft of silk to the underside of whatever object it may be resting upon, and after entangling the hooks of its hind legs in this silk, it lets go the hold of its other legs and hangs down with the head and anterior joints of the body curved as at Figure 66, *a*. In this position it hangs for about twenty-four hours, during which the fluids of the body naturally gravitate towards the up-turned joints, until the latter become so swollen that at last, by a little effort on the part of the larva, the skin bursts along the back behind the head. Through the rent thus made the anterior portion of the pupa is protruded and by constant stretching and contracting the larval skin is slipped and crowded backwards until there is but a small shriveled mass gathered around the tail (Fig. 56, *b*). Now comes the critical period—the culminating point.

The soft and supple chrysalis, yet showing the elongate larval form with distinct traces of its prolegs, hangs heavily from the shrunken skin. From this skin it is to be extricated and firmly attached to the silk outside. It has neither legs nor arms, and we should suppose that it would inevitably fall while endeavoring to accomplish this object. But the task is performed with the utmost surety, though appearing so perilous to us. The supple and contractile joints of the abdomen are made to subserve the purpose of legs, and by suddenly grasping the shrunken larval skin between the folds of two of these joints as with a pair of pincers, the chrysalis disengages the tip of its body and hangs for a moment suspended as at Figure 66, *c*. Then with a few earnest, vigorous, jerking movements it succeeds in sticking the horny point of its tail into the silk, and firmly fastening it by means of a rasp of minute claws with which that point is furnished. Sometimes severe effort is needed before the point is properly fastened, and the chrysalis frequently has to climb by stretching the two joints above those by which it is suspended, and clinging hold of the shriveled skin further up. The moment the point is fastened the chrysalis commences, by a series of violent jerkings, and whirlings to dislodge the larval skin, after which it rests from its efforts and gradually contracts and hardens until it presents the appearance of Figure 67. The really active work lasts but a few minutes, and the insect rarely fails to go through with it successfully. The chrysalis is a beautiful object and as it hangs pendant from some old fence board or from the underside of an Asclepias leaf, it reminds one of some large ear-drop; but though the jeweller could successfully imitate the form, he might well despair of ever reproducing the clear pale green, and the ivory black and golden marks which so characterize it.

[Fig. 67.]

This chrysalis state lasts but a short time, as is the case with all those which are known to suspend themselves nakedly by the tail.

At the end of about the tenth day the dark colors of the future butterfly begin to show through the delicate and transparent skin, and suddenly this skin bursts open near the head and the new-born butterfly gradually extricates itself, and, stretching forth its legs and clambering on to some surrounding object, allows its moist, thickened and contracted wings to hang listlessly from the body. Under the direct influence of the air, the circulation quickens so that the fluids of the body are driven into every portion of these wings, and they visibly expand under the eye, while the other parts of the body gain in strength and firmness. In less than an hour, and often within half an hour, the wings are ready to perform their intended work and our gay Archippus takes his first lesson in æronautics. Ah! what an enviable fellow is he,

> ———Lazily flying
> Over the flower-decked prairies, West;
> Basking in sunshine till day-light is dying,
> And resting all night on Asclepias' breast;
> Joyously dancing,
> Merrily prancing,
> Chasing his lady-love high in the air,
> Fluttering gaily,
> Frolicking daily,
> Free from anxiety, sorrow and care!

THE LARVA ENJOYS GREAT IMMUNITY FROM THE ATTACKS OF BIRDS AND OTHER PREDACEOUS ANIMALS.

Many of our insects, from one cause or another, enjoy a wonderful immunity from the attacks of predaceous and parasitic animals and there exists a curious relation between color and edibility. It is a very general rule that those which have such an immunity from the attacks of enemies, are conspicuously colored and feed openly upon the plants they attack; while those which are persecuted are generally of sombre and evasive colors, and often possess some protective resemblance to the objects upon which they occur, or hide themselves in one way or another. For several years past Mr. J. Jenner Weir, of London, England,—a gentleman whom I had the pleasure of meeting some eleven years ago—has made numerous experiments with the direct view of ascertaining what species of insects are eaten by birds and what species are rejected; and the results of these interesting experiments are recorded in the Transactions of the London Entomological Society (1869, pp. 21–26 and 1870 pp. 337–9). They point conclusively to the facts above given, and Mr. A. G. Butler of the British Museum made corroborating experiments, with, lizards, frogs and spiders. Prompted by these experiments made in England, I was led to make similar ones with our gaily colored Archippus larva, and the result fully accords with that obtained by Mr. Weir; for neither turkeys, chickens, toads or snakes would touch it. The reason why predaceous animals refuse these gaily colored larvæ is not always so easy to explain, but in the present case it is undoubtedly owing to an odor which the larva possesses. This odor is hardly appreciable, when the larvæ are in the open air; but by confining a few of them for a short time in a tight box, it soon becomes apparent, and is pungent and nauseous in the extreme even to our sense of smell, and it is doubtless more intensely so to the keener sense of birds and other animals.

Mr. A. R. Wallace believes that the gay colors of such larvæ are really protective, because if by more sombre colors they were undistinguishable from edible species, they would be seized by birds, and though rejected afterwards, would be so much injured that the probability of their producing butterflies would be very remote, even if they were not killed outright.

The same immunity is enjoyed by our Archippus butterfly in all its stages, and especially in the perfect state, in which the peculiar odor is still stronger, as I have abundantly proved.

The larva does not however enjoy entire immunity from parasites as has been hitherto supposed, for though after extensive experience I have never found any of the numerous Hymenopterous parasites attacking it, it is nevertheless often killed by a Dipterous Tachina-fly. I have never noticed any such parasite in the first brood of larvæ, but last year in the immediate vicinity of St. Louis, not one in fifty of the second brood escaped its fatal work; and this same parasite was by no means confined to one locality, as I received it from Mr. S. S. Rathvon, of Lancaster, Pa., who found the Archippus larvæ and chrysalids badly infested. The eggs of the Tachina-fly must be deposited for the most part while the larvæ are young, for specimens of larvæ taken at the first moult and confined in cages where no flies could get access to them, were frequently parasitised. These victimized larvæ usually succumb a day or two before they are full grown, though occasionally one succeeds in effecting the change to the chrysalis. They grow sickly and, hanging by the hind legs, become flaccid and discolored, while the parasitic maggots pierce the skin and fall to the ground, which they enter to transform. A silky liquid escapes from the breathing pores and from the holes made by these maggots, which, when dry, forms long white semi-elastic threads; and as the discolored larvæ hang by hundreds from the milkweeds, with these glistening filaments, one might at first imagine they had been smitten with some epidemic disease.

The Tachina maggot is not specially distinguishable from the many other larvæ of this kind which are known to infest the bodies of other insects, but the spiracles are encircled by a very distinct dark brown ring.*

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* The larva of this Tachina-fly, after it enters the ground, contracts very rapidly to the pupa state, and if retained on a hard surface, one may watch with interest how, as the chitinous covering thickens and hardens, the dark head is vigorously kept at work underneath it, gnawing or abrading the thickening skin in a constant circle, so as to partially sever that portion which serves as a lid to be easily pushed open by the future fly. I have often wondered how this lid in so many

Our Tachina-flies generally very closely resemble each other, and very little attention has been paid to them in this country. The present species seems to be new to science, but I forbear to describe it for the simple reason that it varies so much in itself and so closely resembles many others, that it would be next to impossible to characterize it sufficiently. It may be provisionally known, for purposes of reference, as the Archippus Tachina-fly—*Tachina* archippivora.* It may be at once distinguished from the two flies described in my second Report (p. 51), and which attack the true Army-worm, not only by the different form and smaller size, but by being of a paler gray, and by lacking the reddish or yellowish tail. The eyes are perfectly smooth. An interesting fact connected with this fly is that it likewise attacked the Fall Army-worm (as already mentioned on page 116, note,) which was so abundant at the same time of year. I have also bred it undescribed cut-worm.

The *Tachinariæ* can only be satisfactorily studied in connection with their habits, and even then they must prove a most difficult Division to work up. The species are very apt to grease in the cabinet and where they do not grease, the colors, especially of the face, lose their brilliancy. I am satisfied that the same species often attacks indifferently many widely distinct larvæ and that there are, in consequence, entomophagic varieties. I have a score of different lots, bred from as many distinct species of Lepidopterous and even Coleopterous larvæ; and the individuals of each lot, often bred from a solitary specimen of some particular species of larva, differ more among themselves than from individuals of some other lot, bred from a distinct species of larva. Indeed, unless there are striking characters, it would be folly for any but the specialist to attempt to describe them. These Tachina-flies, indeed, form such an extensive Division that in order to facilitate study, authors have inclined to erect genera upon characters most trivial and such as would certainly not be looked upon as of more than specific value in other groups. Sixteen specimens bred from *Danais archippus* vary from 0.18—0.30 inch in length and from 0.33—0.60 inch in expanse: some have a rufous spot on the side of the second abdominal joint, while others show no signs of any such spot. From among them two somewhat distinct forms occur in about equal numbers. In the one, which is on an average the largest, the abdomen is rather broader, and when dry shrinks so as to become flat, while the antennæ have the third joint from four to five times as long as the second. In the other the abdomen is rather narrower, remains more cylindrical when dry, and the antennæ have the third joint from five to six times as long as the second. These differences are, I believe, sufficient to cause the specialist to make distinct species or even genera; but as the same two forms occur in those bred from other species of larvæ, and as all the other

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coarctate pupæ was so regularly and smoothly opened by the nascent fly; but am now satisfied from observations made on this particular species, that it is previously prepared by the larva while contracting, in the manner described above. This will be more especially the case where the contracted skin is thick as in *Cuterebra*, *Œstrus*, etc., while in those where the skin is thin and delicate as in *Anthomyia* and many of the smaller *Muscidæ*, the habit probably does not obtain, as the fly can crowd itself out, and the opening is quite irregular, sometimes transverse, at others forming a simple longitudinal slit. I have witnessed the same wonderful forethought in the larva of *Chrysopa*, after spinning its small cocoon. In this case the sharp sickle-like jaws of the larva enable it to cut very finely and smoothly, and the edge of the severed parts show plainly, under the lens, a slight discoloration. The circle inscribed is often, but not always, slightly spiral so that when pushed open the lid hangs as on a hinge. The same habit no doubt prevails in the Lepidopterous genus *Limacodes* and its allies; for I have experimentally proved, by opening several cocoons of *Callochlora viridis*, Reakirt, both while the inmate was yet in the larva or pupa state, that the lid opens with the slightest pressure, and just as regularly as if pushed from within. There is, however, a marked difference in the working in these last two cases and that of our Dipterous larvæ. The former enclose themselves in cocoons, in which they have abundant room to turn round and partially cut their lid, while the Tachina larva performs the work on its own skin while it is hardening and before it has become separated from the transforming body within.

* I forwarded specimens of this fly to Dr. LeBaron, the State Entomologist of Illinois, who is better posted as to the minute generic differences between these flies, than any one else in the West, and he refers it to the genus *Masicera*, Macq., in speaking of which Macquart says: "they are the only *Tachinæ* which have the third joint of the antennæ very long without at the same time having the front very prominent." This and other minor genera of Macquart and Meigen have been discarded by some modern authors, such as Walker and Zetterstedt, and referred to *Tachina*.

details of structure, coloration, etc. are precisely similar, and as these differences themselves graduate, I cannot consider them specific. I have bred the same fly from larvæ of *Prodenia autumnalis* as stated above; also from larvæ of an undescribed Noctuan, closely resembling *Agrotis subgothica*, Haw. These specimens differ only in the rather smaller average size and more slender body, from specimens bred from several other distinct larvæ, and from the pupa of *Cynthia cardui*. It is also an interesting fact that the largest specimens of what appear to be but one species are those bred from the largest larvæ, as for instance that of *Citheronia regalis*.

THE BUTTERFLY OFTEN CONGREGATES IN IMMENSE SWARMS OR BEVIES.

Various butterflies have long been known in Europe, to swarm prodigiously at certain periods; but in this country no other butterfly congregates in such swarms as our Archippus, though the Painted Lady (*Cnythia cardui*), an insect found in all four quarters of the globe, and often seen in swarms in Europe, has been known also to swarm in Canada.

The Archippus butterfly appears in large bevies or flocks almost every year in some part or other of the West. In September, 1868, I received accounts of their sudden appearance in different parts of the city of Madison, Wisconsin, and at Manteno, Ills.; while on the 19th of that month Mr. P. B. Sibley of St. Joseph, Mo., sent me specimens with the statement that he saw millions of them filling the air to the height of three or four hundred feet, for several hours flying from north to south, and quite as numerous as the grasshoppers had been the year before.

In the spring of 1870 I received the following account of such a swarm from L. J. Stroop of Waxahachie, Ellis Co., Texas:

During my ramble this morning (March 31st) I happened upon a flock or bevy of butterflies known as *Danais archippus*, Fabr., containing thirty individuals, four of which I captured for the purpose of identification, only two of which, however, I pinned down. I find them to be of the genuine *archippus*, identical in every respect with specimens bred from the caterpillar by myself last summer, except in that of color, which is somewhat paler in these captured this morning than it was in those bred by me in the summer. They have the appearance of having been on the wing some days.

A little later the same spring similar swarms were noticed in different parts of Kansas, the most remarkable of which was one which occurred at Manhattan about the middle of April, and which, as I learn from Mr. Thos. Wells of that place, came rapidly with a strong wind from the N. W. and filled the atmosphere all around for more than an hour, sometimes so as to eclipse the light. Again, large flocks passed over the same place in a southerly direction, on the evening of the 27th and morning of the 28th September, while at Alton, Illinois, great numbers of them were seen passing in a S. W. direction on the last day of October of the same year.

It would be difficult to give any satisfactory reason for this assembling together of such immense swarms of butterflies. Insects otherwise solitary in their habits sometimes congregate thus for purposes of emigration; but this can hardly be the object of our butterfly bevies. They certainly do not travel very long distances or we should hear more numerous accounts of them. There are two significant facts connected with them from which some corollary might be deduced, namely, that only those species which have a very extended range are known to form such flocks, and that they always travel, under these conditions, in a southerly or south-westerly direction. Mr. Bates* gives an interesting account of the uninterrupted processions of butterflies belonging to the genus *Callidryas*, which passed from morning to night in a southerly direction across the Amazons; and as far as he could ascertain these migrating hordes were composed entirely of males.

If our Archippus flocks should turn out to be all males, this fact may lead to some solution of the cause of their congregating; but I incline to believe the flocks are composed of both sexes. Again, if the swarms occurred during the egg-depositing season, we might even then venture to solve the problem. For it is evident that a species which enjoys such immunity from predaceous animals and which is confined in its diet to a single family of plants, must occasionally multiply in particular districts beyond the capability of the plants to sustain them; and as most female butterflies instinctively refuse to deposit eggs on a plant that has already been abundantly supplied by some other individual, the females of our Archippus would naturally roam in vain for fresh plants when once the latter had all been stocked; and would thus congregate together, and, followed by the males, form migrating bevies. Or we might suppose that after the larvæ had eaten up all the milk-weeds in a district, the butterflies they produced, finding no plants upon which to lay their eggs, would be forced to migrate in swarms. But neither of these suppositions can have much weight from the fact that the swarms occur either late in the fall or early in spring; and the most plausible solution under the circumstances is that, as these are the seasons when the milk-weeds are either destroyed or have not yet started to grow, the butterflies, having nothing to confine their attention and keep them isolated, naturally congregate together, and that when in motion, the low temperature of the seasons instinctively prompts them to wend their way southwards. The probabilities are that these swarms are eventually destroyed, for no species can multiply beyond a certain limit, and when there is not check to increase in one direction, there will be in another. Of course this is as yet all theory and hypothesis, but hypotheses in such cases are necessary, for they are threads on which to string and combine the known parts of a case so as ultimately to arrive at the real truth in the matter.

* Naturalist on the River Amazons, I, p. 249.

THE DISIPPUS BUTTERFLY—*Limenitis disippus*, Godt.

(Lepidoptera, Nymphalidæ).

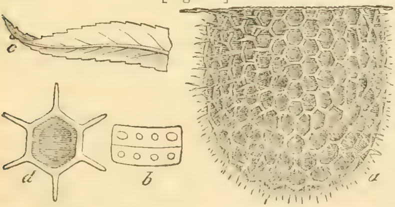
This is another butterfly (Fig. 68) which is well known in the Mississippi Valley. It belongs to a family which agrees with that to which the previous insect belongs, in the front pair of legs being more or less functionally impotent, but differs remarkably from it in the large cell in the centre of each wing never being closed externally by a distinct tubular vein, and in its being generally open towards the outer margin of the wing: also in lacking the small nervule at the base of the front wing, spoken of on page 143.

[Fig. 68.]

The food-plants of the Disippus butterfly are Willow, Poplar and Plum, and though not as numerous as the Archippus, it is yet tolerably common in the Mississippi Valley and occurs sparingly all over the United States and in the West Indies. As will be seen by referring to the figure*, though belonging to an entirely distinct family, it nevertheless bears a great general resemblance to the Archippus butterfly, and this resemblance is rendered more striking by the colors of the two insects being identically the same.

The natural history of this species is fully as interesting as that of the Archippus butterfly—if not more so. The egg which, so far as I am aware, has never before been described and figured, differs remarkably from that of the Archippus butterfly and is well represented at Figure 69, *a* showing it greatly magnified, *c* of the natural size and *d* giving a greatly magnified view of one of the cells with the filamentous processes from each angle of the hexagon. The color is at first pale yellow but soon becomes gray as the embryo within develops. It is usually deposited singly near the tip of the leaf, generally on the underside but often on the upper side; and I have exceptionally found as many as three together, and sometimes one on either side of the leaf, opposed to each other.

[Fig. 69.]

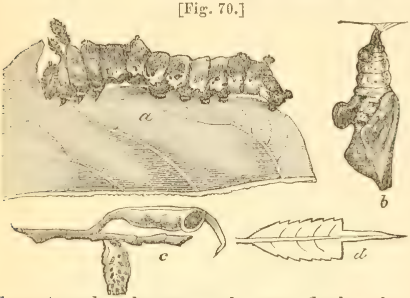


* In Figure 68, which represents the Disippus butterfly, the left wings represent the upper surface, and the right wings, which are detached from the body, represent the lower surface. The difference in the coloration of the two surfaces is but slight in this species, neither does it amount to much in the Archippus butterfly; but in some butterflies and in others belonging to the same genus, it is very considerable.

DESCRIPTION OF THE EGG.—Length 0.38 inch. Diameter at base about the same. Globular, with the top often slightly depressed. Hexagonally reticulate, the cells more or less regular, sunken so as to give the egg a thimble-like, pitted appearance, and about 10 of them in the longitudinal row and 30 in the circumference. Covered with translucent filamentous spines, one arising from every reticulate angle and giving the egg a pubescent appearance. Each spine about as long as the cell is wide, those on the top being longest.

The young larva differs materially from its more mature self, as will be seen from the description which follows. It grows apace, casting off its old coat and devouring the same three times during its growth, and eventually suspending itself by the hind legs and transforming to the chrysalis, frequently within a month from the time of hatching. The mature larva (Fig. 70, *a*) presents a roughened tubercled appearance and varies much in color, the predominan colors being moss-green, brown and creamy-white; the moss-green parts being studded with beautiful light blue points. The pupa Fig. 70, *b*) is marked with burnt-umber brown, ash-gray, flesh-color and silvery white, and is characterized like that of the other species of the genus, by a curious thin almost circular projection which has been likened to a Roman nose, growing out of the middle of its back.

[Fig. 70.]



DESCRIPTION OF MATURE LARVA.—Length 1.20, diameter 0.25 inch. General color either whitish or olive-green. Body thickly granulated. Head dull olive, with dense minute prickles; its vertex bifid and terminating in a pair of prickly cylindrical horns, transversely arranged and each about 0.03 inch long. Back speckled and mottled with olive of different shades above the line of the spiracles, except joints 2 and 8 and the upper part of 7 and 9, but with a continuous pure white line below the spiracles, beneath which white line on joints 4–10 is a large olive patch extending on joints 6–9 to the external tip of the prolegs. A pair of black transversely-arranged dorsal dots in the suture behind joint 2, and a more or less obvious lateral one just above and behind the 5th and 7th pair of stigmata surmounting the lateral white line. Joints 3–7 and 9–11 with more or less, shining, elevated, blue dots. On joint 2 a pair of prickly cylindrical black horns, transversely arranged and 0.16 inch long. On joints 3, 10 and 11 a pair of large dorsal tubercles transversely arranged, each crowned by a little bunch of 8–12 robust prickles. On joint 5 a pair of similar tubercles, but still larger, of a yellowish color, and mamma-like. On joints 4, 6, 7 and 9 tubercles similar to those on joints 3, 10 and 11, but smaller. On joint 12 four black prickly dorsal horns, quadrangularly arranged and each about 0.03 inch long. Stigmata and legs blackish.

Described from many specimens. Such are the prominent and more constant traits of this larva, but it is so variable in the general depth of coloring and in the proportion of the lighter and darker shades that it is next to impossible to frame a description which shall alike agree with half a dozen specimens.

The newly hatched larva presents a quite different appearance. It is 0.09 inch long with a yellowish-brown head twice as large as the first joint and distinctly bilobed. The first joint is also larger than the others. Each joint is divided by a transverse impressed line, and upon the dorsum of each fold thus made are 4 pale elevated spots, the anterior outer ones larger than the rest, as shown at Fig. 69, *b*, especially on joints 2, 3, 5 and 11 where they appear conical with a darker annulation at base. There is a subdorsal and a sub-stigmatal row of similar rounded warts, and they all give rise to little pale bristles or spines. The general color is pale yellowish-brown, mottled with dark streaks, especially below the stigmata. The second period scarcely differs from the first except in the somewhat greater length of the horns. In the third period the horns acquire their mature proportions, and the whole larva becomes more granulated. In the fourth or last the blue points appear and the lateral rows of tubercles lose their conspicuousness to a great extent.

ITS WINTER QUARTERS.

One of the most interesting features in the life-history of our Disippus butterfly is its mode of hibernating. A great many moth larvæ pass the winter in the larva state sheltered in one way or another; but no other American butterfly has hitherto been recorded as hibernating in this state, except the closely related Ursula butterfly,* though no doubt the few other species belonging to the same genus possess a similar habit. Misled, perhaps, by the fact that the butterfly is seen flying about so early in the spring that it could not have had sufficient time to hatch out from the egg and acquire its full larval growth the same season, and with its wings so bright and unworn that it could not have hibernated as a butterfly as some other closely allied species are known to do; Dr. Harris, in his work on Injurious Insects (p. 282) asserts that it hibernates in the pupa state, though he subsequently, in the year 1850, became aware of the facts in the case.†

In reality the larvæ of the autumnal brood, when about one-fourth or one-third grown, build for themselves curious little houses (Fig. 70, *c*), in which they pass the winter. First and foremost—with wise forethought, and being well aware through its natural instincts, that the leaf which it has selected for its house will fall to the ground when the cold weather sets in, unless it takes measures to prevent this—the larva fastens the stem of the leaf with silken cables securely to the twig from which it grows. It then gnaws off the blade of the leaf at its tip end, leaving little else but the mid-rib, as shown in Figure 70, *d*. Finally, it rolls the remaining part of the blade of the leaf into a cylinder, sewing the edges together with silk.‡ The basal portion of the cylinder is of course tapered to a point, as the edges of the leaf are merely drawn together, not overlapped; and invariably the lower side of the leaf forms the outside of the house, so as to have its projecting mid-rib out of the way of the larva, as it reposes snugly in the inside. The whole when finished (Fig. 70, *c*) has somewhat the appearance of the leaf of a miniature pitcher-plant (*Sarracenia*), its length being 0.50–0.65 inch, and its diameter 0.11–0.14 inch.

*There is good reason to believe, however, that some of those butterfly larvæ which habitually protect themselves by a sort of loose cocoon, made by drawing together or rolling up the leaves of their food-plant; likewise pass the winter in the larval state. At least I have known an oak-feeding larva of *Nisoniades juvenalis*, Sm. and Abb., kept by a lady friend of mine, to remain in the larva state nearly all winter before transforming to the chrysalis. But there is not strict analogy between such a case and that of the hibernation of the immature *Disippus*.

† *Harris Correspondence*, p. 245.

‡ In the article in the *Am. Entomologist*—which was the greater part of it written by Mr. Walsh, with my own facts and experience inserted here and there—it is stated that the "gnawed portion of the leaf forming the flap, is bent down and fastened by silken cords, so as to act as a door to the house." After fuller experience, I find that this is very seldom the case, but that the orifice is more often left open.

These curious little cases may be commonly found upon our willows or poplars in the winter time. I have examined hundreds of them, and although they are invariably built upon the same plan, they vary greatly in the degree of perfection which the architect attained; and this is especially the case when they have been built in confinement. The blade on the tip piece is sometimes gnawed off right down to the rib; at others it is left almost as broad as the tube. Sometimes it is bent over the orifice; at others not. They are also much more irregular and ungainly when made from broad leaves such as those of the Silver poplar, than when made from the more narrow leaves of the Willow. These autumnal larvæ have also another peculiar habit not heretofore recorded, and which was first pointed out to me by Mr. J. A. Lintner, of Albany, N. Y. They exhibit a tendency to build from the time they are born, and will always eat the leaves from the side, gnawing large holes and cutting along the sides of the mid-rib, as at Fgure 71, *a*. They commence at the tip and as they work downwards towards the base, they collect the debris into a little bunch, which they fasten with silk to the mid-rib. When the hibernaculum is finished the seam is perfectly smooth and the whole inside is lined with silk. The larva, after completing its work, composes itself for the winter, with the tail towards the orifice. Here it remains till the catkins are in bloom the next spring, when it retreats from its house and commences feeding. Not the least wonderful part of the phenomenon is, that it is only the autumnal brood of larvæ that form pitcher-like houses to live in during the inclement season of the year, the summer brood having no occasion to shelter themselves from the cold. We thus have an instance of a curious architectural instinct being only developed in alternate generations; which is much the same thing as if, with a certain race of men, the great-grandfathers, the fathers and the grandchildren ran wild in the woods, and the grandfathers, the sons and the great-grandchildren lived in houses and led the life of civilized human beings.

[Fig. 71.]

When we duly consider this peculiarity in our Disippus larva, we may well pause and ask—

> What wondrous power enables it so well,
> The coming cold of winter to foretell,
> And to provide for its long torpid rest,
> A house, from means at hand, the very best?

We can but admire the beautiful adaptation of means to an end—no matter how we choose to explain it! There can be little doubt but that many of the phenomena in animal life which we so summarily dispose of by the ready use of that rather blind term "instinct," might be explained in a more natural way. The term is justly applied to those actions which are prompted by exterior influences or peculiarity of organization, and which are performed unconsciously; but by its too general application, most people have acquired a deep-set idea that all animals act under its power, and have nothing akin to our reason; whereas there is hardly anything more certain than that true reason of degree exists very generally in the animal kingdom; or that what we know as pure instinct may have been developed by natural law, *i. e.*, first acquired by experience and afterwards fixed as a habit by heredity.

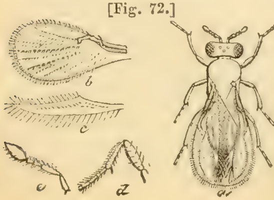
The subtle influences of the late fall which seem to convey through every pulse of nature, intelligence of the approaching winter, and which cause all animals to prepare for their hyperborean sleep, no doubt originally induced the young larva of the ancestral type from which our Disippus and the other species of the genus sprung, to prepare for itself some shelter. The gradually increasing cold and the decrease of nourishment in the leaf, would act as physical prompters, and the pitcher-like house, which at first strikes us as so remarkable, is the simplest structure that could be made with the materials at command. The characteristic smoothness of its food-plant—forbidding as it does the shelter under loose bark which many larvæ seek—would also tend to develop such a trait. That this trait—this instinct—should only be developed under similar conditions to those which gave birth to it, is not so remarkable; and that it does only so develop, seems certain, for I have every reason to believe that while the insect is two-brooded further north, it is sometimes three-brooded with us, and consequently that this peculiar instinct obtains either in the second or third generation, according to circumstances.

ITS PARASITES.

Though not generally known to entomologists, our Disippus butterfly is very subject to the attacks of parasites, at least three distinct species infesting it in the preparatory states. One of these is a *Tachina*-fly, of which I have often noticed the eggs fastened transversely on the back of the neck of the larva, but of which I have not obtained the fly. In all probability it does not destroy the larva till the latter is nearly full grown. The other two I will briefly describe as no mention has heretofore been made of them.

THE DISIPPUS EGG-PARASITE.—The eggs already described were very abundant last fall on a certain clump of willows near Kirkwood, and of about two hundred obtained, fully one-half of them were parasitised. Instead of hatching out into larvæ, as they would have done if they had been unmolested, these last produced little dark colored four-winged flies, from four to six of which

[Fig. 72.]

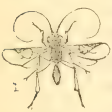


would gnaw their way through the shell of each egg. This little fly belongs to the great *Chalcis* family, and though scarcely more than 0.02 inch long, it can jump to the distance of several inches. Its wings, especially the hind ones, are beautifully fringed with hairs. It is inconspicuously marked, the body being dark brown with the antennæ and legs pale, and the wings iridescent. The highly magnified outlines at Figure 72 will convey a good idea of its appearance, *a* showing the fly with wings folded on the back, *b* one of the front wings, *c* one of the hind wings, *d* one of the legs, and *e* one of the antennæ.

I shall leave the proper determination of this insect to those who pay more particular attention to the CHALCIDIDÆ. It comes nearest the genus *Trichogramma*, Westw., and may be provisionally called *Trichogramma* (?) *minuta*. It differs from that genus and from all other Chalcididan genera with which I am acquainted, in the antennæ being but 5-jointed (scape, plus 4 joints), the scape stout and as long, or longer, than joints 2, 3 and 4 together; joints 3 and 4 small and together as long as joint 2; 5 very stout, fusiform and as long as 2, 3 and 4 together. The legs have the trochanters stout and long, the tibiæ not quite so long nor so stout as the femora, and with a long tooth; the tarsi are 3-jointed, with the joints of equal length and with the claws and pulvilli subobsolete. The abdomen is apparently 6-jointed, the basal joint wide, the 2nd narrower, 2—5 increasing in width till 5 is as wide as 1. The ovipositor of ♀ extends a little beyond the apex, and starts from the anterior edge of the 5th joint.

THE DISIPPUS MICROGASTER.—The third parasite which also very commonly infests the last brood of larvæ, and kills its victim during the second period, is a little black four-winged fly belonging to the genus *Microgaster*. The parasitic maggot eats its way out just before the Disippus larva gets ready to build its winter tenement, and spins a pale yellowish cocoon of silk, either upon the back of its victim or upon the leaf close by; and from this cocoon the fly soon afterwards issues. Figure 73, which represents the Army-worm *Microgaster* enlarged, will convey a good idea of its Disippus relative.

[Fig. 73.]



The genus *Microgaster* is a very extensive one, and the species have not yet been well studied in this country. They are all of small size, and in many instances resemble each other so closely that they can only be satisfactorily studied in connection with their habits and the particular larvæ which they infest. Some appear to confine their attacks to one particular kind of caterpillar, while others infest alike many different species. Thus the one under consideration not only infests the Disippus larva, but I have also bred it from that of the Golden-rod Gall-moth (*Gelechia gallæsolidaginis*, Riley) obtained from Canada; which indicates it to be a widely distributed species.

MICROGASTER LIMENITIDOS, N. Sp.—♂ ♀. Length 0.09 inch. Color pitchy-black. Antennæ black, about as long as body; palpi whitish. *Thorax* minutely punctured. *Abdomen* with the two or three basal joints emarginate and rugose, the terminal joints smooth and polished. *Legs* dusky; front and middle femora yellowish, hind femora black; front and middle tibiæ yellowish, hind tibiæ with terminal half dusky, but the spur pale; front and middle tarsi yellowish tipped w[illegible]h dusky, hind tarsi dusky above, paler below. *Wings* hyaline, iridescent, the nervures and sti[illegible]a black or dark-brown, the radial nervule, the cubital nervules and the exterior nervule of the [illegible]scoidal cell, sub-obsolete.

Described from 6 ♀, 1 ♂, bred from larvæ of *Limenitis disippus,* 3 ♀ bred from larvæ of *Gelechia gallæsolidaginis.* In the latter the nervures of wings are paler and less distinct than in the former. Most of our N. A. species of this genus have been described by Mr. Cresson who has seen this and considers it new. It certainly differs from the other described species.

MIMICRY AS ILLUSTRATED BY THESE TWO BUTTERFLIES, WITH SOME REMARKS ON THE THEORY OF NATURAL SELECTION.

The means by which animals are enabled to escape from their enemies and obtain their food, or in other words to sustain themselves in the great struggle for existence that is continually going on between each species, are as varied as they are wonderful. There is generally a conformity of tint between all animals and their surrounding, and in the higher classes Mr. A. R. Wallace has shown* that in general terms it may be stated that desert animals are desert colored, arctic animals white, and nocturnal animals gray, *i. e.*, of such colors as best to accord with the surroundings. Animals, birds, fishes and reptiles come under this rule to a great extent, and the reader will be amply rewarded by perusing the details given in the valuable and interesting work referred to. But in no Class of animals does this principle of adaptation to environment occur so generally and in such a striking manner as in insects. With them mimicry and other protective resemblances are almost universal, and it may be given as a rule that all insects living above ground, when not naturally protected by odor, luminosity or defensive covering such as hairs, spines, hard shelly wings, etc., or by armor such as stings, beaks, etc., either cover themselves with one substance or another, or similate their surroundings, or mimic either other animals, plants, or even inorganic substances. With insects in their larval states, will this rule especially hold good.

What entomologist has not been deceived by the close resemblance of the beetles belonging to the genus *Chlamys* to the dung of caterpillars; or is not familiar with the quaint and close resemblance of the Walking-sticks and Walking-leaves to the objects from which they take their names? Chapter after chapter might be written on these wonderful imitations which deceive the best trained eyes; and there are many most striking instances among our American insects which have never yet been published and which I hope some day to illustrate. But my present purpose is simply to draw attention to the illustration afforded by the two butterflies which we have been considering.

These striking resemblances were formerly looked upon, for the most part, as curious analogies in nature, intended to carry out the

*Contributions to the Theory of Natural Selection.

general plan of the Creator; but viewed in the light of modern science, and especially by that of the Darwinian development hypothesis, they have acquired an immense significance. One of the most interesting phases of this mimicry, and one which has only within the last few years been brought to light, is the imitation by an otherwise defenseless butterfly, of one whose great numbers and wide distribution indicate that it enjoys peculiar advantages. This specific imitation of one butterfly by another is precisely of the same nature as the mimicking of a vegetable or inorganic substance, and may consequently be just as properly termed mimicry. Some authors seem to make a distinction between this so-called mimicry and what is known as "protective resemblance," while others again misconceive the true import of the word "mimicry" as used in this connection. Thus, Maj. J. R. Muhleman in an essay on "Mimicry in Insects," read before the Central Illinois Horticultural Society this winter, gave the word so broad an interpretation as to apply it to the possum-playing of some insects, and even to the supposed and far-fetched resemblances such as that of the female Canker-worm to a plant-louse, and of the female Bag-worm to a Dipterous maggot. True mimicry can only occur where it is of benefit to the species, no matter whether the benefit be derived by enabling harmless species to avoid their enemies in one way or another; or by enabling predaceous species to deceive their prey by assimilating the form and colors of the latter.

As already stated, the particular group to which our Archippus butterfly belongs is a large one, and the species comprising it are very numerous. They are especially abundant in South America, and like our own species, they all possess a pungent odor which seems to pervade all the juices of their system. So much is this the case that according to Mr. Wallace,* when an entomologist "squeezes the breast of one of them between his fingers to kill it, a yellow liquid exudes which stains the skin, and the smell of which can only be got rid of by time and repeated washings." The wings of these butterflies, as may be seen by referring to Figure 63, are rather longer than usual, but their flight is comparatively slow, and they do not dodge and zig-zag about with sudden skips and jerks as the "Skippers," (HESPERIDÆ,) are known to do. They furthermore possess no adaptive coloring to protect them during repose, for they take no pains to hide themselves, and their colors are bright, and those of the underside as conspicuous as those of the upper.

Hence we cannot assume that they are enabled, by their peculiar mode of flying, to escape to a great extent those cannibal animals that would otherwise catch and devour them; and if we propose to account for their prodigious abundance at all, we are driven to have recourse to some other hypothesis. Indeed, so far is it from being the case that it is their mode of flight which enables them to

*Contributions, etc., p. 78.

escape from their cannibal foes, that Mr. H. W. Bates, the English naturalist, who spent eleven years in the Valley of the Amazon River, studying the natural history of the insects of that region, where this particular group of butterflies is very copiously represented, declares that he never saw a single one of them attacked by any cannibal foe whatever, whether bird, or Dragon-fly, or lizard, or *Asilus*-fly.

It is therefore reasonable to assume that their peculiar odor renders them unpalatable to animals of prey. We have seen that the Archippus butterfly enjoys an almost perfect immunity from the attacks of predaceous animals, consequent, in all probability, upon this peculiar odor which attaches to it both in the larval and perfect states. In this case the supposition is even strengthened by the fact that the only parasite known to attack it is a *Tachina*-fly, belonging to a family which is notoriously defiant of strong odors, the larvæ often rioting in filth and the flies many of them known to be especially attracted to such odors.

Now there is another large group of butterflies, known as the *Pieris* family, to which the white cabbage butterflies belong, which were mentioned in my last Report (pp. 104–110.) This group differs widely in structure from the *Danais* group, and is represented by many species in the Valley of the Amazons; but instead of the species being exceedingly abundant in individuals, as in the case of those belonging to the *Danais* family, it is quite the contrary; the proportion between the number of individuals belonging respectively to two of the commonest genera of either group (*Leptalis* and *Ithomia*) being only 1 to 1000. Hence, it is reasonable to infer that this group must be much persecuted by cannibal foes, and such has been found to be the case.*

The colors found in the species of the *Danais* family are red, yellow, orange, white and black; while only the last two colors obtain in the *Pieris* family, the white being sometimes tinged with greenish yellow. So far so good. We see flitting about in the great Valley of the Amazons, vast swarms of long-winged butterflies, gorgeously dressed in red, orange, yellow, white and black; and certain short-winged butterflies, in very much smaller numbers, whose proper livery is but the plain black and white that befits a funeral. We see the former enjoy an entire immunity from the attacks of all predaceous animals, and the latter snapped up by every hungry bird, Dragon-fly or *Asilus*-fly that happens to come across them. Will it be believed, now, that there are certain particular species of the homely, much persecuted, short-winged group, that assume the livery worn by certain particular species of their gaily dressed compatriots, and actually even copy their elongated wings? Yet such is the indubitable fact. In the Memoir of Mr. Bates, already referred to, will be found

*These facts were first brought to light about nine years ago, by Mr. Bates, in a most interesting and valuable Memoir, published in the Transactions of the Linnæan Society, (Vol. XXIII, p. 495.)

beautiful colored figures, in the highest style of art, both of the species that mimic and of those that are mimicked; and no one that looks at those figures with an unprejudiced eye can believe for a moment that the resemblance is merely accidental.

Even the practiced eye of the entomologist is sometimes deceived by these close resemblances, and to illustrate, I cannot do better than to quote Mr. Bates's own language:

These imitative resemblances, of which hundreds of instances could be cited, are full of interest, and fill us with the greater astonishment the closer we investigate them; for some show a minute and palpably intentional likeness which is perfectly staggering. I have found that those features of the portrait are most attended to by nature, which produce the most effective deception when the insects are seen in nature. The faithfulness of the resemblance, in many cases, is not so striking when they are seen in the cabinet. Although I had daily practice in insect-collecting for many years, and was always on my guard, I was constantly deceived by them when in the woods. (p. 507).

Mr. Bates accounts for these singular cases of mimicry by supposing that, ages and ages ago, certain individuals of this plainly-dressed and much-persecuted *Pieris* family happened to vary slightly-so as to resemble slightly some species or other belonging to the gaily-dressed and unpalatable *Danais* family; that, in consequence of this slight resemblance, they were sometimes mistaken for their more fortunate compatriots by cannibal animals, which would otherwise have preyed upon them forthwith; and consequently that they survived long enough to propagate their species, while almost all the individuals that had not varied in this particular manner perished prematurely by a violent death. Now, we know that, in the language of breeders and stock-raisers, "like produces like," which is what naturalists express by the well-known term of the "Law of Inheritance." Hence the descendents of this primordial race of imitative butterflies would naturally, most of them, vary in the same manner as did their ancestors from the normal type; and some of them would probably vary in a still more marked manner and in the same direction. These last individuals, as they would bear a still closer resemblance to the unpalatable butterflies, would of course stand a still better chance of surviving and propagating their species, in the course of that great Struggle for Existence, which we see going on all around us, not only among the inferior animals, but among the human species itself. By the perpetual repetition of this process, during indefinite ages, that perfect imitation of the imitated butterfly would at length be formed, which at first view appears so utterly inexplicable. And when it had once been formed, the very same process that originally formed it would afterwards keep it up to the standard of perfection. For all individuals, that varied in a backward direction towards the primordial type, would be more liable than the rest to be devoured in early life by cannibals, and would therefore be less likely than the rest to propagate their own image in succeeding generations. The whole process, indeed, is so beautifully simple and intelligible, that, but for certain prepossessions and prejudices, it would at once command the assent of every logical mind. In fact, it is strictly analogous to the common operation of "rogueing" a bed of seedlings, which every gardener is familiar with. The only difference is that, when the gardener pulls up what he calls the "rogues" out of a thousand seedling tulips, *i. e.*, those which deviate from the standard of perfection which he is aiming to attain, he acts with the definite object of preventing the further propagation of those so-called "rogues;" whereas, when cannibal animals destroy the "rogues" among the imitative butterflies, they are of course perfectly ignorant of the consequences likely to follow, and act wholly and solely for the gratification of their own carnal appetites. In short, the whole phenomenon is explained on the theory of Natural Selection as expounded by Darwin.

Since the publication of Mr. Bates's paper, a great many additional cases of similar mimicry among butterflies have been observed by Mr. Wallace* in the Malayan region of South America, and by Mr. Trimen in South Africa.† But though most of these wonderful cases of mimicry occur in the tropics, where insect development is so rapid and species are so abundant, we also have a striking instance of similar mimicry in our two N. A. butterflies, *Archippus* and *Disippus*. The resemblance between them must long ago have been noticed, for it is so servile that Prof. Jaeger in his *Life of North American Insects*, has actually favored his readers with a figure of the Disippus and gravely informs them that it is the Archippus butterfly. Indeed it is far more striking than my figures would indicate, and in a state of nature the two insects could hardly be distinguished at a short distance by the sharpest eyes. The fact that these two species offer an illustration of similar mimicry to that observed so frequently in the tropics, was first made clear by Mr. Walsh and myself in the *American Entomologist* for June, 1869; and the facts which have since come to my knowledge all tend to confirm the opinion.

The only other species belonging to the same genus as our Disippus butterfly, which occurs in the Mississippi Valley, is the Ursula butterfly‡ (*Limenitis ursula*, Fabr.), an insect which differs remarkably from our Disippus in being of a sombre blue-black color, with its wings bordered both above and below with blue, and below with a series of dull orange spots inside the blue border. Its larva feeds on Willow, Scrub-oak, Whortleberry, Cherry and Plum, and as already stated, has the same habits as that of Disippus, which it resembles so closely as scarcely to be distinguishable. The pupæ of the two species are also undistinguishable.

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* See the Chapter on Mimicry among Lepidoptera in his Contributions, etc.

† See his paper on "Mimetic Analogies among African Butterflies," in the Transactions of the Linnæan Society for 1868.

‡ There are seven described species of N. A. *Limenitis*, but with the exception of the two above named they are all confined to the more eastern or western portions of the Continent.

If this Ursula butterfly were placed side by side with the Archippus butterfly, everybody would say at once that no two species could possibly be more unlike in the general style of their coloration. Clearly, therefore, it cannot be considered as in any wise mimicking the latter. Now, the Ursula butterfly is found everywhere throughout the Northern States wherever the Disippus butterfly is met with; and yet, while the latter is a common and abundant species, the former is quite rare. This is certainly the case in the Mississippi Valley, and will, according to my own experience, and that of others* very generally hold true all over the country.

To what are we to attribute this fact? It can scarcely be owing to structural differences in the external organization of the two species; for the two belong to one and the same genus. It surely cannot be because the larvæ of the former are more exposed to the attacks of predaceous animals than those of the latter; for they inhabit the same, or very nearly the same trees, and in size, shape and general coloration the two are almost exactly alike. Certainly it can not be because the pupæ of one species are more subject to be devoured by birds, insects, etc., than those of the other species; for it is impossible to tell one pupa from another when placed side by side. The only cause to which we can reasonably attribute the great abundance of the Disippus butterfly and the comparative rarity of the Ursula butterfly is, that the former mimicks the Archippus butterfly, as has been shown above, and is consequently often mistaken by birds, tree-frogs, Dragon-flies, *Asilus*-flies and other beasts of prey for its unsavory prototype and allowed to escape with impunity, while the latter, having no such disguise, is ruthlessly devoured by every insect-eating animal that can get hold of it.

All the facts lead to such a conclusion. The mimicked species enjoys an almost perfect immunity from the attacks of enemies in all its stages, while the mimicker is persecuted by several. The mimicker is often found in company with the mimicked, as I have myself, and as others have witnessed.† But what is still more conclusive is the fact observed by Mr. S. H. Scudder‡ that in the extreme Southern States where the Disippus butterfly occurs, and Archippus is replaced

* According to Mr. J. A. Lintner, *Ursula* is "rare" and *Disippus* is found abundantly in New York. (*Proc. Ent. Soc. Phil.*, III., pp. 63–4.) According to Mr. J. Kirkpatrick *Ursula* is "rather rare" and *Disippus* "common in the fall" in Ohio. (*Ibid.*, p. 329.) According to Mr. Sam H. Scudder, *Ursula* is "rather rare" and *Disippus* is "common" in New England. (*Proc. Essex Inst.*, III., p. 165.) According to Mr. Billings, who does not seem to have met with any *Ursula* at all, *Disippus* is "very common from July to October" in Canada West. (*Canad. Entom.*, I., p. 45.) There appear to be some exceptions to this rule, however, for Mr. Thos. W Higginson, of Newport, R. I., declares (*Am. Entomologist*, II., p. 177.) that *Ursula* is one of the commonest of the large butterflies there and decidedly more so than *Disippus*. I was also informed while at Troy last fall, that the former outnumbered the latter in the vicinity of New York City in the year 1868, though the previous years it had been quite rare. These exceptions to the rule may be owing to one cause or another, but I shall attempt to explain them when I come to consider the objections to the theory which I espouse.

† Mrs. Mary Treat, of Vineland, N. J., writes that *Archippus* was unusually abundant there last fall, and that she found *Disippus* in company with it.

‡ *Nature*, Vol. III, p. 147.

by the Berenice butterfly—a species of the same genus and of similar appearance but of darker color—the color of the mimetic Disippus deepens nearly or quite to the tint of the Southern *Danais*. Thus it is that facts before unintelligible are explained by Darwinism!

In a discussion on the difficulties of Natural Selection, which took place in late numbers of the London journal *Nature*, some ingenious objections have been urged. As many of them have especial reference to the mimicry we have been noticing, a brief summary of these objections will prove interesting in this connection, the more especially as all objections must in the end only serve to strengthen a theory, if that theory is sound.

Mr. Alfred W. Bennett* undertakes to show upon mathematical considerations, that Natural Selection could not produce these mimetic forms. He assumes that it would take 1000 steps to enable the normal form of a *Leptalis* for instance, to pass into the protective form of an *Ithomia*; that no change less than one-fiftieth of the whole alteration—*i. e.* 20 steps—would be of any use to the insect, and that the alterations in the early stages, being useless to the animal, would not be preserved, and even if they were, could not be attributed to Natural Selection, but to an accumulation of chances. He reiterates what has already been well shown and acknowledged by Darwinians, namely, that Natural Selection cannot produce the first change, and asks with good reason why the same principle that works the first change should not also work the subsequent changes? He does not dispute the secondary power of Natural Selection, but believes in an unconscious organizing intelligence which co-operates with it to produce the mimetic results. He endeavors to strengthen his position by showing that there is a close connection between instinct and mimicry, and ventures the theory that "the power of mimetism, so far as is known at present, runs almost *pari passu* with the development of the nervous system."

The essay is an able and interesting one, and the arguments are skillful and ingenious. It pays due and just respect to Darwinism and forcibly presents the fact, which no one has denied, that some other power than natural selection acts in producing first change The mathematical argument, however, will have little weight with those who fully appreciate the changes in Lepidoptera that take place in nature. No entomologist who has had any experience in rearing Lepidoptera will admit with Mr. Bennett that 1000 steps are necessary to produce mimetic resemblance, and when this foundation stone of his objection is taken away, much of his other reasoning which is built upon it becomes weak. Instances of great and sudden variation among butterflies and more particularly among moths are by

* *Nature*, Vol. III, pp. 30–33.

no means rare. In this Report instances of great variation in species have been given, and hundreds of others might be cited.*

Mr. Bennett furthermore, as Mr. Wallace subsequently pointed out,† fails to take into consideration the fact that each butterfly produces not only one, but numerous offspring, that the right variation has, by the hypothesis which he combats, a greater chance of surviving than the rest, and that at each succeeding generation, the influence of heredity becomes more and more powerful, causing the chance of the right variation to become greater and greater. He also appears to forget that this imitation in butterflies is of comparatively rare occurrence, and that the mimickers generally belong to genera which naturally show a tendency to depart from the normal coloring of their own family and to approach that of the mimicked, so that the first steps are greatly facilitated. I consider therefore that the mathematical objection utterly falls to the ground; but that there is something in the closing ideas which Mr. Bennett throws out, which may yet lead to important discoveries, I can very well conceive. Indeed it must be rash to deny some such influence as he describes when we reflect upon the extraordinary power which the mind of the mother exerts, during pregnancy, on her offspring; and when we further consider that Mr. Wallace himself admits that man's present mental and physical condition could not have been brought about by natural selection alone. It must be obvious to every one, however, that such an admission is no argument against the theory of Natural Selection. All other modifying influences though they may lessen her potency simply assist her in her grand work.

The next objector we find in Mr. Saml. H. Scudder of Boston, Mass.,‡ who, while admitting that there can be no possible doubt of the fact of mimicry, questions its advantage among butterflies, since the greatest destruction occurs in their preparatory states. But as he refers especially to the two butterflies we have been treating of and as from the context it appears that he is also aware of the existence of some of the parasites which I have described, I will quote the greater portion of his letter which was written from Cairo, Egypt, under date of November 9th, 1870; and, will afterwards reply to his objections:

"But of how much actual benefit to the mimetic species is this so-called "protective" resemblance? It seems to occur where it can be of the least possible advantage to the species. The great sources of destruction here, as in all groups of animals, are in early life. How large a proportion of the eggs that are laid by butterflies ever finally produce imagines? Let those answer who have attempted to follow their history in their native haunts. My experience leads me to believe that at the very least, nine-tenths—perhaps ninety-nine hundredths—never reach maturity. Hymenop-

*A most remarkable case came under my notice the past summer. From a single batch of flattened and ribbed eggs, overlapping each other under a piece of Hickory bark, I succeeded in raising eighteen imagines of *Catocala phalanga*, Guen. The upper wings vary greatly in the individuals, and in one specimen the ground-color and markings are so very aberrant, that there is more difference between it and some of the others belonging to the same batch, than there is between the latter and a dozen distinct species.

†*Nature*, III, p. 49.

‡*Ibid*, Vol. III, p. 147.

terous and Dipterous parasites beset them at every step. The eggs, although so small and often so heavily ridged, cannot escape the ovipositors of the tiny Pteromali, while in attempting to breed caterpillars taken in the field, the chance is so greatly against the evolution of a butterfly, that Hymenopterists actually choose this method of supplying their cabinets. 'Of two hundred larvæ of *Pieris brassicæ*,' Mr. Drewsen, of Denmark, writes to me, 'I obtained only twenty pupæ, all the rest were attacked by *Microgaster glomeratus*, and my own attempts with the larvæ of *Pyrameis Atalanta*, both in America and Europe, have been even more unavailing. These caterpillars seem to be peripatetic banqueting halls of Microgasters and Tachinæ.

"Now it is a curious fact that while the globular egg of *Limenitis Misippus*,* with its deeply-pitted shell, defended by long filamentous spines, is constantly attacked by parasites; and the grotesque hump-backed, strangely-colored caterpillar of the same species is likewise infested to an extraordinary degree, I have been unable to discover by very careful search any evidence that the egg or larva of *Danais Archippus* is ever pierced by a parasite; yet the egg is not small and only lightly ribbed, and the caterpillar large, fleshy, smooth-skinned, and gaily banded, living on the widely-separated leaves of Asclepias, with no attempt at concealment. The abundance of the imago of the Danais is then due quite as much to the immunity of the egg and larva from the attacks of parasites, as to any freedom it may itself enjoy from pursuit by insectivorous birds. [1.]

"Although I have hunted butterflies for fifteen years, I confess I have never seen one in a bird's bill, and my faith in that method of lessening their numbers is very slight. Birds, too, must be their greater foes in earlier life; and the chances of living, which are certainly against them before they take wing, seem afterwards rather in their favour, at least, until they have accomplished their mission. [2.]

"If, then, such an extraordinary element as Mimicry is to be summoned to the aid of Natural Selection, and can perform its task in such a masterly manner, why has it been made to waste its energies upon unimportant material? If the object of the resemblance be protection, why does not the unfortunate caterpillar of the Limenitis mimic the more favoured larva of the Danais? [3.]

"I cannot now consult the writings of Messrs. Wallace and Bates, nor do I remember their statements respecting the abundance of the mimetic species compared to that of its normal congeners. In my own country *Limenitis Misippus* is, as a general rule, more common than *L. Ursula*, but the difference in their numbers is not very marked. It is by no means as great as one would expect had Mimicry in the imago state so strong a protective power as has been assumed. [4.] Two closely allied species occupying the same geographical area, do not often occur in the same abundance, whatever be the cause, and the disparity in numbers in these two species of Limenitis is no greate than occurs in many instances where mimicry plays no part. [5.]"

[1.] No one will deny the facts, after what I have already set forth.

[2.] Such an experience from a butterfly hunter surprises me Individually I have on several occasions seen butterflies captured by birds, and have seen Dragon-flies dart after them. Any amount of evidence might be collected on this head, and Mr. Scudder has already been answered by Mr. Arthur G. Butler† of the British Museum, who mentions often having seen birds catch and devour the unprotected species upon the wing, while he has received abundant evidence respecting the immunity of the *Danais* group. "T. G. B." of St Johns College, Cambridge, has also often seen the common English sparrow capture *Vanessa urticæ* and *Pieris rapæ*‡; while Mr. Wallace has shown that great numbers of butterflies are destroyed on the wing by insectivorous birds such as jacamars, trogons and puff-birds, and gives conclusive evidence that while our Disippus congeners, the *Nymphalidæ*, suffer such persecution, the Archippus congeners do not.§ Thus, though there

*The reader must bear in mind that *Misippus* is but a synonym for *Disippus*.

† *Nature* III, p. 165.

‡ *Ibid*, p. 166.

§ Contributions, etc., p. 79.

seems to be no record of any person having actually seen a bird or other animal attack the species of *Limenitis* in this country, there is every reason to believe that they will do so. This fact once being admitted, it must also be admitted that the resemblance of *Disippus* to *Archippus* serves the former as a protection. I freely grant, however, that the species of *Limenitis* are kept under by enemies far more in the preparatory states than in the perfect state; but this fact only adds importance to the mimicry of *Disippus* as throwing light upon its greater numbers. The larvæ and pupæ of *Ursula* and *Disippus* so closely resemble each other that it is not likely their enemies would make any discrimination between them; and if in a given district where *Archippus* is abundant, the two former species, by the undue multiplication of their enemies in some particular year, should be so thinned out while in the immature states, that only a dozen imagines of each were perfected in an area of say 100 square miles; it becomes obvious that by deceiving the birds, or by associating with *Archippus*, the twelve specimens of *Disippus* would stand a much better chance of escape than those of *Ursula*, and that consequently more would succeed in perpetuating the species.

[3.] Natural Selection *does not*, therefore, waste its energies upon unimportant material, in giving protection to the perfect insect; and any one, with a little reflection, will perceive that there are the best of reasons why the unfortunate caterpillar of *Limenitis* cannot mimic the more favored larva of *Danais*. *They never come in contact!* The perfect insects are enabled by flight to associate together; but their larvæ—the one being confined to plants of the Willow and Poplar families, the other strictly to those of the Milkweed family—can never so associate. That there is, however, an effort at protection in the preparatory stages of *Limenitis*, no entomologist who has studied them in the field will deny. The egg, as Mr. Scudder has admitted, is in a measure protected by the long filamentous spines, which may protect it from the attacks of some of the very numerous parasites that might otherwise aid in exterminating it. The larva is very variable, and wears a remarkable protective resemblance to its surroundings. I have often noticed that in the mature specimens found on the dark Scrub willow the dark colors predominate; that those found on Golden willow are much brighter and greener, and the palest specimen I ever saw was found upon Silver poplar. Only those who have diligently searched for these larva can fully appreciate the protection which their appearance affords. In one instance I chanced to espy a large full grown specimen of *Disippus* on a Golden willow not more than seven feet high. The specimen on account of its brightness and greenness struck me as remarkable, and I searched for others. In taking a casual glance I could detect none, but after a diligent search I succeeded in finding seven specimens, and then left, fully convinced that I had espied every one upon the tree. The next day, however, my confidence in the sharpness of my eyes was considerably shaken, for upon returning to the same small tree I succeeded in finding three more, all of them more than half grown.

As to the chrysalis, it bears a very strong resemblance to a bit of bird dung, and for the first few hours of its being, while the parts are yet soft and elongated this resemblance is truly striking.

[4.] I have shown that the disparity in numbers between *Disippus* and *Ursula* is very marked in the Mississippi Valley, and there is every reason to believe that the former is most abundant wherever its protector, the Archippus butterfly, abounds. I have Mr. Scudder's own authority for the statement that the latter is comparatively rare in the northeastern States, and my own experience would indicate such to be the case. Now it is extremely probable that where *Archippus* abounds, birds and other natural enemies are continually reminded of its nauseous qualities both by smell and taste.*

It would very naturally follow therefore, that where *Archippus* is rare, birds would not be so continually warned of its evil properties, and the deceptive resemblance in Disippus would lose much of its protective power in such a case. This explanation of the fact that *Ursula* is in some districts more common than *Disippus* will acquire greater force, if we find that such a state of things occurs only where *Archippus* is rare, and the facts as they at present stand indicate such to be the case.

Mr. Wallace† is inclined to account for the fact that *Ursula* is in some districts as numerous, or more so than *Disippus*, on the supposition that *Ursula* is also a mimicker, resembling the Philenor swallow-tail (*Papilio philenor*, Drury‡) especially on the underside, which is exposed when the insects are at rest. We must, however, be very cautious in accepting such resemblances as cases of mimicry, without first ascertaining whether there can be any real cause for mimicry or whether the two butterflies ever associate together. Under the circumstances I incline to believe that the markings on the underside of *Ursula* are of a generic character since they obtain in other N. A., species of *Limenitis*; and that the resemblance to *P. philenor* is merely casual and bears no more relation to mimicry than does the close resemblance of certain plants belonging to different continents. *P. philenor* is itself a rare insect where *Ursula* is common, and must always be so on account of the scarcity of its food-plant; and, if anything, *Ursula* bears a greater general resemblance to *P. troilus*, Linn, and *P. asterias*, Drury, which are both more common species. It also bears a greater resemblance upon the upper surface to the female of *Argynnis Diana*, Cramer.

*A singular fact bearing on this point has been communicated to me by Mr. Otto Lugger of Chicago, a gentleman who takes much interest in entomology and is a good collector. While employed on the U. S. Lake Survey he once saw a bird dart after an Archippus butterfly, seize it and immediately drop it without devouring the body. The butterfly dropped close by his side and he picked it up and examined it, and had no means at the time of accounting for the singular action of the bird.

† *Nature* III, p. 166.

‡ See my 2nd Rep. Fig. 86.

[5] This in no wise alters the fact, however, of the existence of mimicry in *Disippus*, which Mr. Scudder fully admits. It is, therefore no argument against Natural Selection having produced such mimicry. Because we are able to explain the principle power working to produce the relative abundance of one species, compared with another that is closely allied, it does not follow that we must also give the varied influences which cause the relative abundance or rarity of other species in other groups!

The third objector is Mr. A. Murray, who undertakes to show that these mimetic resemblances have nothing to do with Nnaural Selection.* He takes it upon himself to assert that every inch of ground which Mr. Bates has gone over is "mined and unsound"—that the "bad smell has not been observed in North America where similar mimicry occurs"; and that "birds and insects of prey hunt by sight and not by smell." Any one who will take the trouble to carefully read the paper in which these assertions occur, will, I have little doubt come to the conclusion that it is the author's ground which is "mined and unsound." The second assertion, as I have already shown, is false; and even if the third is admitted, it does not in the least affect the argument in favor of Natural Selection, because the fact nevertheless remains that some groups do enjoy immunity from the attacks of birds while others do not. The manner in which Mr. Murray would account for this mimicry is by hybridization, and he endeavors to draw a parallel between the phenomenon and hybridization in plants. He carries little weight in his arguments, which were in a measure anticipated by Mr. Bates himself, and have since been refuted by Mr. Butler and Mr. Wallace.† He forgets that hybridization cannot play any part in the mimicry of insects to the vegetable kingdom, or to backgrounds generally. It has never been known to occur between insects of different Orders, families, or even genera, and produce fertile offspring,‡ while mimicry does occur even between insects of distinct Orders; and though he of course supposes the hybridization to have taken place at a very remote date, when the structural characters of the mimickers and mimicked were less specialized, yet had such been the case, these structural characters would not now remain so distinct between them, because it is quite fair to suppose that the hybrids would partake of the characters of each parent. Indeed the assumption of the theory is unsupported by facts. He ignores in a measure the great difference in the affinities of species belonging to the natural Orders of plants, and those belonging to the Orders of insects, and depreciates the importance of the latter by comparing the Orders

Nature III, pp. 154-6.

† *Ibid.*, III, p. 165.

‡ Cases of hybridization even between species of the same genus are very rare, and it is doubtful if the hybrids would ever be fertile; and as to hybrids between genera I do not think a case has ever been recorded. In 1865 I succeeded in obtaining thorough coitus between a ♂ *Attacus cynthia*, Hubn., and ♀ *Attacus cecropia*, Linn., but for some reason the eggs resulting from this intercourse did not hatch. Last year I succeeded in producing an equally thorough coitus between a ♂ *Attacus cecropia*, Linn., and a ♀ *Attacus polyphemus*, Linn., but the eggs subsequently deposited by the latter were likewise infertile.

simply to families in other animals—thus showing that he has not a due appreciation of the true affinities of insects.

It must not be forgotten that Natural Selection is not the only power at work producing this mimicry. This we do not claim. There is an inherent tendency in all things to vary—a fact universally admitted. We may not be able to fully comprehend the causes producing this first variation, for they are complicated, and depend on numerous external conditions, and physical and mental influences. But our ignorance in this respect does not affect the theory, because "spontaneous" change is the material out of which Natural Selection has fixed and perfected the mimicry and adaptation; and it is not necessary to know how the "spontaneous" change is produced to learn the origin of the mimicry. Whatever be the causes of variation, and whether or not they continue to act after the first change takes place, Natural Selection is still potent, for the change would be perfectly inoperative in producing specific character without it.

There may be a hundred different influences that have led *Disippus* to mimic *Archippus*. The resemblance being purely colorational, there may have been a tendency from the first in the color of the former to approach that of the latter, and this is rendered very probable from the fact that the red-brown color occurs more or less in all the N. A. species of the genus.* The very smell which protects *Archippus* may have had, and may still have, attractions for its mimicker, for Mr. Henry Edwards found that a Californian species of the same genus (*Limenitis Bredowii*) was greatly attracted by any offensive odor.† Again, when we reflect that we owe so many of our flowers and fruits to what are called "sports," which are simply instances of great and sudden variation; it is not difficult to imagine that the mimicry of *Disippus* may be due in a measure to some such sudden original variation—an idea that is greatly strengthened by the fact that instances of such great variation are common with butterflies and moths, and that one is known to occur in the very genus *Limenitis*.‡

We may give due weight to the somewhat Lamarckian theory advanced by Mr. Bennett; we may attach the greatest importance to the influence of physical conditions—and we know that similar habitat sometimes produces modification of allied forms in a similar direc-

* In the seven described N. A. species of *Limenitis*, namely, *L. disippus*, Godt., *Ursula*, Fabr., *Proserpina*, Edw., *Weidemeyerii*, Edw., *Arthemis*, Drury, *Lorquini*, Boisd. and *Bredowii*, Hubn. the red color obtains more or less in all of them, especially on the under side, and this is more particularly the case in the last two. I also possess specimens of *Ursula* in which a very distinct shade of red blends with the blue-black and spreads over the upper surface of the primaries, and is in two individuals quite marked towards the apices. That the blue and black is closely connected with, and shows a tendency to affiliate with the brick-red and black, or *vice versa*, we may also reasonably infer from the wonderful contrast existing between the ♂ and ♀ *Argynnis Diana*, Cram., the former colors obtaining in the ♀ and the latter in the ♂.

† *Butterflies of North America*, by Wm. H. Edwards. It is impossible to make any explicit reference to this beautiful work as it is not paged: this, to my mind, is a deplorable oversight.

‡ *Limenitis Sibylla* figured in "Newman's English Butterflies," and referred to by S. N. Carvalho, Jr., in *Nature*, Vol. III, p. 66.

tion—but all these agencies will not produce specific imitation of one species by another, for they only prepare the way for it. It is therefore quite evident that such imitation can only be brought about to use Mr. Bennett's own words, "by the continuous preservation, through countless generations of those individuals which spontaneously approach most nearly to the ultimate forms;" and Natural Selection is the Preserver.

I have thus endeavored to frankly consider the objections raised against the theory of Natural Selection, as it applies to the mimicry of our two N. A. butterflies. It would be out of place here, and might justly be considered a work of supererogation on my part to undertake to defend it on more general grounds. It has been so well developed by Darwin, Wallace, Bates, and many other writers, both English, French and German, that it only asks a hearing to be understood and appreciated. The rapid increase of organisms is demonstrable, and the consequent struggle for existence, since, all organisms considered, there are as many deaths as births, is manifest. The result of this struggle is the survival of the fittest, by which organic forms are constantly changing to keep in harmony with the changed conditions which it is demonstrable have taken place, and are still taking place, in the inorganic world. And, to use Wallace's language, "as the changes of conditions are permanent changes in the sense of not reverting back to identical previous conditions, the changes of organic forms must be in the same sense permanent, and thus originate species."

That its influence and importance has been overrated by some writers is not at all unlikely, for Mr. Darwin himself now believes that he at first attributed too much to its action; and certain it is that it could have had no influence in producing many purely ornamental features of certain animals, that are of no use to the species thus ornamented. No theory was ever yet propounded, however, which has so well stood the test of scientific investigation in all departments of research, or that has such a power of absorbing new facts; and no theory has in such a short time been so very generally accepted by the leading scientific minds.

A two-fold reason has led me to give it prominence in this Report. First, I believe that when well understood it must prove of the utmost importance to the husbandman, by giving him an intelligent conception of the growth and development of animal and plant life about him, and by adding zest and interest to his efforts to produce superior varieties and breeds. Secondly, my studies of insect life led me several years ago to appreciate the hypothesis, and the more I become acquainted with these tiny beings in the field, the more I become convinced of its truth and importance. It is not to be wondered at that the entomologist who treats the different varieties in any group as independent species, should have implicit faith in the absolute distinctness and immutability of species; but whenever he pays more attention to the biological part of his science, and studies insects more in the field, his views must necessarily change. Indeed, next to plants, insects offer, perhaps, the best material for the inquiring mind to work upon. Their rapid multiplication, the rapid manner in which one generation is often followed by another, the wonderful manner in which they are often affected by climate and food, especially during the preparatory or adolescent stages—all tend to furnish variation for Natural Selection to work upon, in a profusion unknown in the higher animals. Though the formation of a species in the other Classes of animals may never be in man's power to trace, on account of the great lapse of time required; it seems highly probable that the process may some day be traced in insects, and Mr. Bates gives strong proof of the derivation of one butterfly (*Heliconius thelxiope*) from another (*Heliconius melpomene*) and a clear insight into the manner in which the gradual modifications take place, till at last the two forms cease to interbreed, and are in every sense of the word true species.*

After all, the great objection to the theory of Natural Selection, in the minds of many, is, that it involves belief in the broader doctrine of Development—of Evolution. Very true! But, no matter how much importance be attached to Natural Selection, the fundamental truth of the development of species is now almost universally accepted by scientific men best able to judge of its merits; and those who have not considered the subject may be excused from judging of it. Indeed it can hardly any longer be considered a hypothesis: it is in reality established as a law, and as eminent a naturalist as Carl Vogt has even ventured the assertion that "no one in Europe dares any longer sustain the independent and direct creation of species." Development is a fact in nature, and the revelations of science strengthen faith in the universality of her laws and principles. No one can study well the facts in natural science, or the truths of philology, which point to corresponding results, without feeling more strongly than ever words can express, the general truth of the doctrine. Our own Agassiz is about the only great naturalist who opposes it, though it is rather significant that many of his leading pupils have, within the last few years, boldly proclaimed their faith in Darwinism. If there is one error in Agassiz' life, I take it to be the authority which he has lent to that popular prejudice which has always opposed inquiry into the order of nature, and which has ignorantly accused Darwin of atheism.

A theory which is so opposed to deep-set tradition and to present theological interpretations, must necessarily at first meet with very great objection. Such has been the history of all great scientific truths, for we have Agassiz' own words that "the history of the sciences is present to tell us that there are few of the great truths now recognized which have not been treated

*Naturalist on the River Amazons, Vol. 1, pp. 255–265.

as chimerical and blasphemous before they were demonstrated.' Truth must, however, in the end prevail!

Science and theology have little in common, and will, perhaps, always be at variance, but science and true religion are twin-sisters, and will ever go hand in hand. In the present question, theology affirms supernatural causes beyond man's investigation, and consequently sets an embargo on inquiry; while science affirms natural causes within the limits of investigation: the one appeals to man's senses, the other appeals to man's reason, whose throne should never be abdicated, and whose power to trace effects to antecedent causes is unlimited.

The belief that Darwinism is irreligious and atheistic, is widespread; but this belief is the direct result of prejudging and unfounded prejudice. For no one who understands the theory can entertain such an idea for a moment. The individual is not created by a special miracle, but develops by natural means. Yet no one would claim that the individual was any the less a creation. And so when it is argued that species also develop by natural means—according to natural law; they are none the less therefore creations! It is only a question as to the method which the Almighty employs; for not only does the development hypothesis imply an Infinite cause, but to use Prof. E. L. Youman's language "its conception is as much grander than the common theological idea, as the conception of the Cosmos which science has revealed, transcends the petty ideas of the world which were entertained in the grovelling infancy of the race!" Creation by a process of development is tangible and conceivable, whereas we can have no knowledge and no conception of creation without any process.

Haeckel, one of Darwin's strongest supporters, says: "In recognizing the unity of nature and the efficacy of the Divine Spirit in everything, we may perhaps lose the hypothesis of a personal Creator, but we evidently gain the idea of a Divine Spirit, which pervades the whole universe. God is the highest, the most living, the most active unit through all things which only appear as sensuous representatives for sensuous creatures." Can such men be called atheists or materialists?

The supposition that the creative mind produced all things as we now find them, by a single act of unstinted power, requiring only such time as can be reckoned by ourselves, is the direct outgrowth of our own comparatively feeble minds—is to gauge the power of the Almighty by our own. The supposition that he works through natural law, originally ordained, and by a constant exercise of his prerogative, is a far higher and more comprehensive conception; for it helps to broaden our views and enables us to grasp something more than we have hitherto done. It carries us back æons in the past, and shows us that creation has not only been continuous but still endures, and it helps us to rise to sublimest contemplation of that unknown Infinity which pervades all.

Von Baer has truly remarked that "the scientific investigation of Nature strives to learn everything in detail, in order to get nearer to the cause of everything," and though we may not always reach the goal we aim at, we should not therefore cease to try. The law of the age is progress, and the point we reach to-day will form our starting point to-morrow. Every step which enables us to more truly interpret the workings of the Divine Mind in nature, necessarily brings us nearer to, and gives us a more intelligent idea, of a Creator. Each new insight into the significances and harmonies around us, helps us to lift the mystic veil and behold with awe and wonder the might and majesty of God—to converse with him as flesh with unknown Infinity: and I look forward to the day when the development of species will not only be universally recognized as a law, among naturalists; but when the liberal-minded theologian will revere the names of men like Darwin, who help to a higher conception of creation—instead of anathematizing them and ignorantly charging to their doctrines those atheistic tendencies which in times past have been vainly thrown up to those of so many other great, clear-thinking, discovering minds!

ERRATA.

Page 7, line 18 from bottom, for "*Hylecctus*," read "*Hylecœtus*."
Page 57, line 18, add "*c*" before the first "*h*."
Page 58, line 2 from bottom, for "*fornudolosus*" read "*formidolosus*."

ERRATA OMITTED IN THE FIRST REPORT.

Page 14, line 16 from bottom, for "females" read "males." Page 30, note, for "F" read "T." Page 32, line 14 from bottom, for "III" read "V;" same page, line 7 from bottom, for "XIII" read "VIII." Page 38, line 5, for "*Tredeim*" read "*Tredecim*." Page 53, line 19 from bottom, for "laid" read "lain." Page 54, line 4 from bottom, for "hatch" read "are deposited." Page 87, line 11 from bottom, for "F" read "T." Page 132, line 16, for "*ampelopsis*" read "*ampelopsidos*." Page 150, line 6, for "ruddy" read "vigorous;" same page, line 26, for "*thyridopteryx*" read "*thyridopterygis*." Page 154, in the heading, for "*zeas*" read "*zeæ*." Page 155, line 13 from bottom, for "zeas" read "zeæ." Page 173, line 3 from bottom, for "it" read "the more liquid parts;" same page, under the heading, read ("Lepidoptera, Tineidæ.") Page 174, line 3 from bottom, for "*Solidaga*" read "*Solidago*." Page 175, line 32, add "front" before "wing." Page 178, lines 2 and 3, for "*gelechia*" read "*gelechiæ*."

INDEX.

A

B

C

D

E

F

G

H

I

L

M

N

O

P

Q

S

T

V

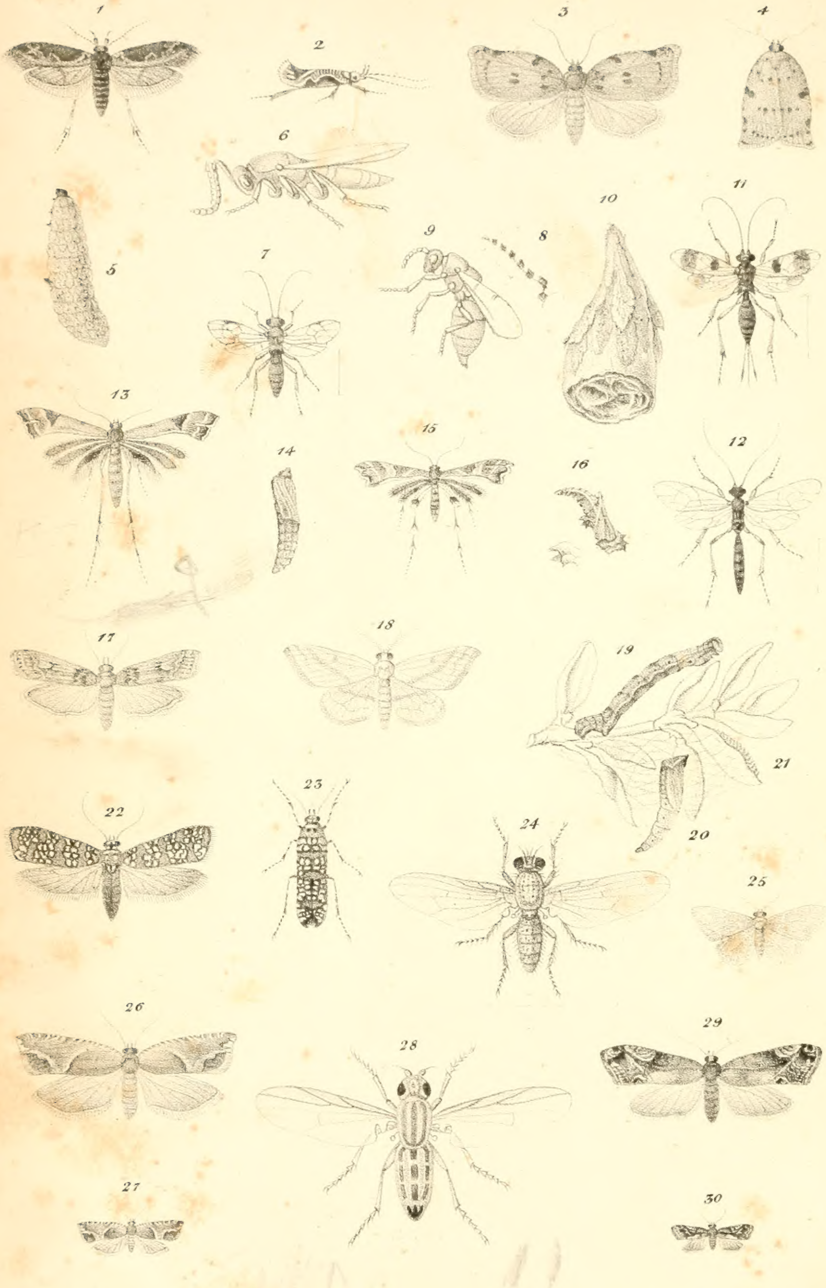
W

X

Drawn by D. Wiest.

George M. Huddleston

George M. Huddleston



Drawn by D. Wiest. Bowen & C° lith. Philad^a.

FIRST ANNUAL REPORT

ON THE

Noxious,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
STATE ENTOMOLOGIST.

JEFFERSON CITY, MO.,
ELLWOOD KIRBY, PUBLIC PRINTER.
1869.

INTRODUCTORY.

To the Members of the Missouri State Board of Agriculture:

Gentlemen:—I herewith present my first annual report on the Noxious, Beneficial and other Insects of the State of Missouri, pursuant to your instructions of April 1st, 1868.

It is neither so full nor so valuable as I hope to make its successors, should the office be continued. This is principally owing to the fact, that but eight months have elapsed since my appointment, and that the natural history of a number of the insects that received my attention during the summer, can only be given after they have completed their transformations, which will require one, two and in some cases, even three years.

I have been exceedingly gratified at the warm reception which I have met with from all quarters. Wherever I have been, from one end of the State to the other, the cordial hand has been extended, and I have found our farmers and fruit-growers thoroughly alive to the importance of the work, for they know full well that they must fight intelligently, their tiny but mighty insect foes, if they wish reward for their labors. During the year 1868, insects injurious to our fruits have been unusually numerous, but it may well be asked whether this increase is not a meteorological effect, as was suggested by Mr. W. C. Flagg, in his *ad interim* report to the Illinois State Horticultural Society, rather than one caused by the increase of our products. The severe drouth of 1867, had a peculiarly injurious effect on many trees, and it seems quite evident that certain insects increase more rapidly in injured fruits and injured trees than in those which are healthy and vigorous. The part, indeed, which insects principally have to play in the economy of this world, is that of scavengers. They hasten the decay and dissolution of unhealthy vegetable organism, the quicker to convert it into mould, and make room for healthy plants; while they multiply at such a prodigious rate, that whenever the conditions are at all favorable to the increase of a particular species, that species appears as if by magic, over vast districts of country, and commits sad havoc to either orchard or field crops, as the case may be.

With this view of the matter, we might materially check the increase of some insects, by anticipating Nature in her operations, and cutting down such trees as have been injured from whatsoever cause, so that they shall not remain from year to year as a hiding place for noxious insects, or as a hot-bed for equally injurious funguses.

The peach crop failed pretty generally on account of the great increase of the Plum Curculio, and the opinion has been advanced and extensively published, that this insect will cause a failure of that crop in certain districts for very many years to come. Let the wise place no confidence in such predictions, for the predictors can have but a vague conception of the grand scheme of Nature, and of the laws which govern both animal and vegetable life. For many reasons unnecessary to mention, the prospect for a good crop the year succeeding an entire failure, is greater than at any other period—at least so far as insects are concerned. Because an insect is numerous and destructive one year, therefore it will be even more so the next, is apparently plausible but very fallacious reasoning. Every one of the thousands of species which are known to exist, multiplies at a sufficient rate to entirely cover our globe, in a comparatively short time, if nothing hindered; and the struggle and warfare necessary to enable all the different species to exist and hold their own, causes a constant fluctuation in the relative proportion of each. We have an illustration of this in the case of the Colorado Potato Beetle; for in those districts where it had caused so much alarm in 1866 and 1867, its enemies have so increased that it was comparatively harmless in 1868.

The importance of the study of Entomology has already become apparent to every tiller of the soil, but there is yet a class of citizens who fail to appreciate the laborious efforts of an Entomologist, and cannot conceive how the "study of bugs," as they term it, will redound to the good of a State or community. For the benefit of such, let me say, that in his last annual address the president of our State Horticultural Society, estimated the annual loss to our State from insect depredations at SIXTY MILLION DOLLARS! Now, allowing this estimate to be twice as great as the facts will warrant, the sum is yet quite enormous. It is not possible by any preventive measures to save the whole of this immense sum, but it is perfectly practicable to save a large percentage of it, and in this assertion I think the following pages will bear me out. A knowledge of the habits and transformations of insects frequently gives the clue to their easy eradication and destruction, and enables the agriculturist and horticulturist to *prevent* their ravages in the future. It likewise enables them to distinguish between their insect friends and insect enemies, and guards them against the impositions of the numerous quacks and nostrum-venders, who, with high-sounding words are constantly putting forth every energy to sell their vile compositions. Such a knowledge of insects the farmer has not time to acquire, for it is only obtained by an immense amount of hard labor in the field and anxious deliberation in the closet. Hence, the wisdom of having a State officer who can devote his whole time to the work.

Fully aware that I write for those who, as a rule, are unversed in Entomology, I have endeavored to treat of each insect with as little of the nomenclature of science as is consistent with clearness of expression. Yet, as much that is of scientific interest, such as descriptions of new species, must necessarily be inserted, I have had such descriptions printed in a type of smaller size than the text, so that it can be skipped if desirable, at the time of reading, and easily referred to for comparison, with specimens which one is desirous of naming. I have also endeavored to illustrate, as far as possible, the insects of which this report treats, believing that good illustration forms the basis of successful teaching in a science with which the general husbandman is not expected to be acquainted; for the eye conveys to the mind, in an instant, what the ear would fail to do in an hour. The practical man cares little to what genus or family an insect belongs, so long as he can tell whether it be friend or foe. He must become familiarized with the insects about him without having necessarily to overcome scientific detail and technicality.

I have made no effort at a systematic arrangement of the insects treated of. Indeed, that were useless for the purpose in view; but in order that the reader may refer the more readily to any particular insect which interests him, I have separated them into three series—Noxious, Beneficial and Innoxious—and attached a very full index. For the benefit of those who are making a study of Entomology, I have also given, with each species, the order and family to which it belongs, in parenthesis under each heading.

So far as possible, I have used a common name for each insect, knowing that the scientific name is remembered with greater difficulty, and is, consequently, distasteful to many. But as popular names are very loosely applied, and the same name often refers to different insects in different localities, a great deal of confusion would ensue without the scientific name, which is, therefore, invariably added for the most part in parenthesis, so that it may be skipped without interfering in any way with the sense of the text.

The sign ♂ wherever used in this report, is an abbreviation for the word male, the sign ♀ for female and the sign ☿ for neuter.

Wherever the illustrations are enlarged, they are accompanied by hair-lines, which designate their natural size.

Where the measurement of an insect is given, the dimensions are expressed in inches and the fractional parts of an inch, 0.25, thus implying a quarter of an inch, and 1.25 one inch and a quarter, etc.

Many letters were addressed to me, during the summer, inquiring as to the value of the new carbolic acid, which has been so much spoken of. Having fully experimented with it during the summer, I am well pleased with it as an insect destroyer. But a word of warning in its use is necessary. It is also known by the name of cresylic acid, the difference between the two being one of purity only. Many, having seen it recommended, ordered the crude acid, and, using it—no matter how much diluted—they found to their sorrow that it killed their plants. *Carbolic acid mixes well with alkalies, but not with water, and it can only be used as a saponaceous compound.* This fact must be borne in mind by those who wish to use it.

As I shall frequently have occasion to refer to the "AMERICAN ENTOMOLOGIST," it is but proper to say, that in conjunction with Mr. Benj. D. Walsh, State Entomologist of Illinois, I commenced last September, the publication of that journal. It is devoted to Economic Entomology, and is published monthly, by R. P. Studley & Co., of St. Louis, at $1,00 per annum. We felt that pending the issuing of our annual reports, something was needed, as a more frequent means of communication with the people. The paper has received the highest encomiums from the press throughout the country, and as an enterprise has proved successful beyond our expectations—evidence of the great demand for, and need of, the kind of information which it gives.

As there must necessarily be a limit to a report of this character, I am compelled to defer till another year, accounts of the Chinch Bug, Rocky Mountain Grasshopper, and some other insects which attracted general attention during the year, and do so the more willingly, that their habits have been pretty fully given in former publications, and in the above periodical.

In conclusion, I tender my sincere thanks to those gentlemen, throughout the country, who have assisted me in one way or another, and especially to the Superintendents of the Pacific, Iron Mountain, Hannibal & St. Joseph, and North Missouri Railroads, for free passes over their respective routes.

Respectfully submitted,

CHARLES V. RILEY,
State Entomologist.

ST. LOUIS, MO., Dec. 2d, 1868.

NOXIOUS INSECTS.

THE BARK-LICE OF THE APPLE-TREE.

(Homoptera, Coccidæ.)

[Fig. 1.]

There are two species of Bark-lice that attack the Apple-tree in the United States, which I will briefly describe.

The first, which is a native North American insect, is now known as Harris's Bark-louse (*Aspidiotus Harrisii*, Walsh.) The color of the scale is dirty white, and its form is irregular, being usually egg-shaped; but, however variable in outline, it is always quite flat and causes the infested tree to wear the appearance of Figure 1; while the minute eggs which are found under it in winter time are invariably blood red or lake-red. This species has scarcely ever been known to increase sufficiently to do material damage, for the reason doubtless that there have, hitherto, always been natural enemies and parasites enough to keep it in due bounds. Though I have not witnessed it in Missouri myself, I am informed by several persons that it occurs in the northern part of the State, and a communication from R. B. Palmer, of Hartville, Wright county, published in the *Rural World*, of October 15, 1866, and stating that the lice are destroying the best apple orchards in that neighborhood, evidently refers to this species.

The second species, which is known as the Oyster-shell Bark-louse (*Aspidiotus conchiformis*, Gmélin), is by no means so harmless however, for it is one of the most pernicious and destructive insects, which the apple-grower in the Northern States has to contend with. This species presents the appearance of Figure 2, and may always be distinguished from the former by having a very uniform muscle-shaped scale of an ash-gray color (the identical color of the bark), and by these scales containing, in the winter time, not red, but pure white colored eggs.

There is scarcely an apple-orchard in Northern Illinois, in Iowa or in Wisconsin, that has not suffered more or less from its attacks, and many an one has been slowly but surely bled to death by this tiny sap-sucker. It was introduced into the Eastern States more than seventy years ago from Europe, and had already reached as far west as Wisconsin in 1840, from whence it spread at a most alarming rate, throughout the districts bordering on Lake Michigan. It occurs at the present time in Minnesota and Iowa, but whether or not it extends westward beyond the Missouri river, there are no data to show. Its extension southward is undoubtedly limited, for though so abundant in the northern half of Illinois, observation has clearly proved that it cannot exist in the southern half of the same State. I have also experimentally proved that it cannot exist in the latitude of St. Louis, the experiment being made in the following manner: On the 12th of May last, I received some scales from Jesse Hodgson, of Panola, in Woodford county, Illinois, the eggs under which were at that time hatching. Upon fastening the bark containing these scales to the twigs of a living apple-tree, that being in a position where I could easily watch them, the young bark-lice crawled actively over these living twigs, and soon fastened themselves, as is their wont, around the buds. They soon began to secrete the waxy fibres, shown at Figure 3, *a*, and in time assumed the white appearance of the first scale, which has been very aptly termed the *larval* scale by Mr. Walsh. But the growth at this point was arrested and they all soon afterwards died. As there were three twigs thickly covered, and as I could discover no parasites or cannibals of any kind, it is to my mind conclusive that THIS BARK-LOUSE CANNOT EXIST FURTHER SOUTH IN MISSOURI THAN ST. LOUIS. The experience of others is to the same effect, for Dr. Morse informs me that certain apple trees which he procured from the North, and which he planted at Kirkwood, St. Louis county, some years ago, though covered at that time with these bark-lice, are now entirely free of them; and Mr. Wm. Muir, of Fox Creek, in the same county, has had a similar experience with trees which he imported several years ago from Burrell & Co., of Lockport, N. Y., and which at the time of their receipt were very badly infested.

[Fig. 2.]

The fruit-growers of Southern Missouri, have therefore little to fear from this Oyster-shell Bark-louse, and it is not unlikely that it would die out in the country considerably north of St. Louis, if imported there; but, as it exists and flourishes near the southern border of Iowa, and extends, in Illinois, below our northern boundary, there is every reason to believe that it will flourish in the extreme northern counties of our State if once introduced there. Now, up to the present time, it has not made its appearance, as far as I can learn, in any of the orchards in that part of Missouri, and it seems that, as a State, we are entirely exempt from this most grievous orchard pest. In order to definitely decide this matter I took particular pains, while at Hannibal during the summer, to inquire of the old fruit men there on this point, and even John Fry, one of the oldest settlers, has never heard of its appearance in that vicinity. The responses from numerous letters that were sent, with the same query, to men living in other northern parts of the State, are to the same effect. Believing therefore, that this insect *can* flourish in our extreme northern counties if once introduced there, and that at present the fruit-growers of that region are exempt from it, I cannot too strongly urge them to hold the vantage ground they now have. *Let every man therefore who reads this report, and who contemplates planting an apple orchard in North Missouri, in duty to himself and to his neighbors, subject every young tree which he receives from northern or eastern nurseries, to a rigorous inspection; and if any be found infested, let them be thoroughly cleansed before planting. By this means alone, can we hope to retain that immunity, which we have so far enjoyed!*

It should indeed be a maxim with fruit growers to inspect all young trees received from a distance; for many of our very worst insect foes, such as the Canker-worm, Root-louse, etc., are undoubtedly transported from one place to another, principally on nursery stock. In order that the Oyster-shell Bark-louse may be at once recognized and thoroughly understood, I will proceed with its history:

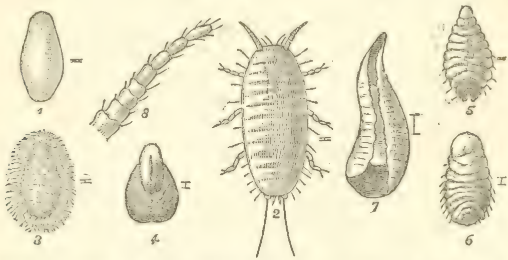
During the summer of 1867, three independent observers were closely studying the habits of this insect in Northern Illinois, unbeknown to each other, namely: Dr. H. Shimer, at Mount Carroll; Benj. D. Walsh, at Rock Island, and myself, at Chicago. Up to this time, though it had frequently been treated of, yet much that was recorded of its history was mere conjecture. For instance, Harris states that there are two broods each year, while Fitch assures us that the scales are the bodies of the gravid females, covering and protecting their eggs; neither of which is the case.

The gist of Dr. Shimer's observations which were recorded in a paper published in the Transactions of the American Entomological Society, (Vol. 1, No. 4) are, 1st—that he discovered that the tarsal joint of the newly hatched larva, which is very small, possesses no claw, but is furnished at the extremity with four fleshy hair-like processes upon which the young louse walks, and which he calls *digituli;* 2d—that the scale is constructed by the insect, and consists of the moulted skins of the louse, soldered together by some secretion which he believes to be the excrement. In these characteristics, he finds sufficient grounds for separating this insect from the Bark-louse family (COCCIDÆ) to which it has been referred by Linnæus, Gœffroy, Fabricius, Burmeister, Reaumur, Curtis, Westwood, and many other authors, and erects a new family (LEPIDOSAPHIDÆ), and a new genus (*Lepidosaphes*), to contain it. He furthermore takes it upon himself to deny what all these authors have insisted upon, viz:—that the loss of members, or the change from the perfect and active larval form represented at Figure 3, 3, to the motionless and memberless forms shown at 5 and 6 of the same figure, is an evidence of the degeneration or degradation in this insect as it approaches the imago state.

Mr. Walsh, whose observations are recorded in his First Annual Report, as Acting State Entomologist of Illinois, found nothing to induce him to separate this insect from the old genus *Aspidiotus* in the Bark-louse family, to which it had hitherto been referred. He also showed that there were three distinct growths of the scale, differing from each other in size and color, which he named respectively the "*larval scale*," "*medial scale*" and "*anal sack*." He also inclined to believe that both the "medial scale" and "anal sack" were formed "by the anal surface of the original young larva being at two successive periods abnormally dilated and extended backwards, in the form of a sack closed at tip; and that, after this process is accomplished, the insect always moults or sloughs off the whole of the external scale." As to the formation of the "larval scale" he offers no explanation.

My own observations will be found in the "Report of the Committee on Entomology," published in the Transactions of the Illinois State Horticultural Society for 1867—pp. 109–112. Having had no opportunity of continuing them the past summer, and as they will convey a good idea of this insect's mode of growth, I repeat them in part.

[Fig. 3*.]



The young lice usually leave the scales during the first week in June. Prior to their hatching, the eggs which were previously snow-white, become yellowish, and if the weather turn cool, immediately after hatching, they will remain for two or three days under the scales before dispersing over the tree. The following notes as before stated, were made in Cook County, Illinois.

June 6th.—Most of the eggs are hatched, but the young have not yet left the scales.

*These figures are highly magnified, the hair lines at their sides approximating the natural lengths. 1, egg—natural size scarcely .01. 2, larva, as it appears when running over the twigs—natural length .01. 3, its appearance soon after becoming fixed. 4, appearance of scale after the second plate is formed. 5, form of louse (ventral view) soon after losing its members. 6, form of louse (ventral view) when full grown and just about to deposit. 7, fully formed scale, containing louse, as it appears from the underside, when raised. 8, highly magnified antenna of larva, showing joints.

June 9th.—The past two days have been exceedingly warm, the thermometer rising above 90 degrees F. in the shade, and the young lice are running all over the twigs.

June 11th.—They have all become fixed, having gathered in the greatest numbers around the base of the lateral shoots of the terminal twigs.

June 12th.—A white, waxy secretion commences to issue from the body, in the shape of very fine, delicate threads (see Fig. 3, 3).

June 22d.—They have increased materially in size, the waxy secretion vanishing soon after the last date, leaving what appears to be the body, of a yellowish brown color, though in reality the body is underneath and separate, and has lost all trace of members.

July 1st.—Though watched every day, there is no perceptible change since the 22d of June.

July 2d.—They are now 0.03 long, or three times as large as when hatched, and a thin, waxy secretion commences to appear at the posterior end.

July 6th.—This secretion has increased rapidly, and taken on a somewhat oval form, with usually a slight cut or depression posteriorly. It appears quite distinct from the original yellowish-brown portion, and is duller, or of a more grayish color. On raising it carefully, the louse is seen underneath, yellowish, of a flattened form, the anterior tapering more than the posterior portion, which latter is always distinguished by having a patch of bright reddish-brown (see Fig. 3, 5). Though from analogy it must have a beak of some kind, it is so exceedingly fine and fragile that I have never been able perceive it.

July 10th.—There seems to be another pause in the growth, the scale presenting the appearance of Figure 3, 4.

July 12th.—A third plate or secretion has commenced from the posterior portion.

July 15th.—This last plate enlarges rapidly, and is the exact color of the bark.

July 20th.—The three plates are at present readily distinguished; the last, which is considerably larger than the two others together, having usually taken a slight curve, which gives the scale its characteristic form.

August 1st.—Their growth is to all appearances completed, the scale measuring 0.12, while the louse measure but 0.05, occupying thus about half the space within. The three different growths are now not readily distinguished, though the narrow end is always reddish-brown. On lifting the scale the insect does not fall out, being retained by a slight whitish fringe extending from each side of the scale (see Fig. 3, 7).

August 12th.—Some of them have commenced to deposit eggs.

August 28th.—The eggs are now, apparently, all deposited, and I have watched with interest, as the deposition went on, the body of the parent louse shrinking day by day, instead of extending and becoming gravid, until it is now a mere atom at the anterior or narrow end of the scale, in a few days scarcely to be noticed at all.

The oyster-shell bark-louse produces but one brood annually, and these eggs, therefore, remain under the scales for more than nine months of the year, subjected alike to the continuous warmth of the fall months, and to the severe frosts of winter; freezing and thawing again and again, without their vitality being in the least impaired. In order to show the conclusions which I came to, after the above observations, I will, in a measure repeat them.

All writers on this Bark-louse, copying after Fitch and others, tell you that the scale you see on your trees is the gravid body of the female insect. Now, though for aught I know the body proper of the female may, in some Coccidan species, extend and cover the eggs she deposits, it is no such thing in this instance; and I am prepared to affirm that the scale is no more the insect's gravid body than is the empty muscle shell the distended outer membrane of the muscle, or the oyster shell that of the oyster.

How this scale is formed I do not profess to have discovered. With regard to our native white species, already referred to (p. 7), Mr. Walsh, in the Practical Entomologist for December last, refutes Harris's theory, namely, that it is formed in the same way as the down which exudes from other lice, and shows, with some plausibility, that it may consist of the cast-off skins of the insect. Now, in my own humble opinion, with the imported species under consideration, I am inclined to uphold Harris, for the following reasons: besides the fine waxy filaments which it secretes when becoming fixed, I have found that, even before these are thrown out, it is covered with a fine, white bloom, proving that it can and does secrete from the general surface; having carefully lifted the scale, every day during the growth of the third portion referred to, the louse has invariably been found in the same shape and condition, without apparent connection with it, while the scale, to all appearances, actually increases in bulk during the time the eggs are being deposited. Furthermore, the exuviæ of such a tiny insect would be infinitely thinner and more delicate than is the scale, and as the insections, especially of the verter, are always plainly visible with a glass, in the louse, we should expect to see them in the scale, which is, however, perfectly smooth. Again, the louse is of the same color throughout its growth, while at one time the three parts of the scale are perceptibly different in this respect. Moreover, Reaumur long ago (Memoires, tom. IV., p. 26) observed a species occurring on the peach in France to cast its skin in flakes, much in the manner as many of our *Dipterous* and *Hymenopterous* larvæ are known to do; while he also described a species (pp. 64, 65, ibid.) occuring on the vine, which covered its eggs with a white, gummy, cottony secretion; and Mr. Walsh himself, in the February number of the little monthly already referred to, p. 57, speaking of a species occurring on the under surface of the leaves of the *Olea* *fragrans*, shows how in that species the "scale" is not formed of the lifeless body of the female, but is a distinct integument, constructed by the female to protect herself and her eggs, and probably *secreted from the general surface of the body.*

However, I believe that the entomologist will have about as difficult a task to ascertain its real mode of growth as would the physiologist to learn how the flesh on your fingers acquires its natural form. We might with equal reason try to learn why and how the thousand different excrescences and galls caused by insects are formed! Why is it that the larva hatching from an egg deposited on a rose leaf by a little four-winged fly, the *Rhodites ignota* of Osten Sacken, causes a peculiar growth or gall in the form of a mangel-wurzel, or beet seed, to surround it, while that of a similar fly, belonging to the very same genus—the *Rhodites radicum* of Osten Sacken—hatched from eggs deposited in the root of the same plant, causes an entirely different gall? Why is it that the puncture of a little yellow louse, *Pemphigus* (?) *vitifoliæ*, Fitch (or as Henry Shimer, of Mt. Carroll, would have it, *Daktylosphæra vitifoliæ*), by puncturing a grape leaf, causes an unnatural growth to surround and entomb it in the shape of the little green globular galls of different sizes, so common on Clinton grape vines, while the same sized puncture of another louse (*Aphis vitis*, Scopoli) produces no such effect? Why, again, does a little Lepidopterous larva, often found in the golden rod (the larva of *Gelechia gallæsolidaginis*, described in a future chapter of this report), produce an elongated hollow gall, while a Dipterous larva (*Trypeta solidaginis*, Fitch), in a neighboring stalk produces one that is round and solid? Or, lastly, why should the suction of different species of Dipterous larvæ (*Cecidomyiæ*), produce the wonderful galls found on our willows, causing in many instances not only a total change in the texture of the leaf, but also in its mode of growth?

To me the formation of our Bark-louse scale appears somewhat analagous to all of these, and a thousand other such phenomena known to science; and in answering how such growths, peculiar to each species, are formed, or why each is so constant in its character, I can only say that it is their nature; or, with Devere, "that knowledge of first causes belongs to Him alone, who allows the eye of man to see final causes only." The more we endeavor to study the why and the wherefore of these things the more the mind is filled with the idea of Infinity, and escaping from all visible impressions of space and time rises to sublimest contemplation of the Creator.

The growth of the scale under consideration, to my mind, depends no more on the will of the louse underneath it than does the sponge on that of the slimy, jelly-like creature which secretes it, or the coral on that of its polype; or, to use a more patent illustration, than the growth of our bones, though secreted from our organs, depends on our will.

By carefully lifting one of these scales during the months of July and August, any of you may find the true louse underneath, occupying but a portion of, and being quite separate from it.

From analogy we may presume that there are males as well as females of this species, since winged males are known to occur in the genus *Aspidiotus*, and it has been my great aim and hope to discover this gentleman. Though an extremely small percentage of the scales may generally be found dwarfed and empty during the first days of August, suggesting that a male may have escaped, yet as likely as not these may have been killed by some cause or other. In the latter part of June I counted five hundred scales on a single twig, and marked them to prevent mistake or confusion in recognizing them again. After watching them steadily, and carefully lifting each one on the 28th of August, they all, with the exception of two, were found to contain eggs. The same average would doubtless have been found over the whole tree; and from this fact I am constrained to believe that as a rule no males appear, and that if there be exceptions where they do occur, they are in such proportion as to be of little avail. Mr. Shimer, in speaking of the Clinton grape gall, already alluded to, states that he opened thousands of them before he found a male; and it is difficult to conceive what effect a single delicate male, shut up in a gall, could have on the thousands of others not dignified by his presence. When we reflect on the abnormities occurring among our plant-lice, I see no reason why our bark-lice should not be hermaphrodite as a rule, and yet occasionally produce males. They are still lower in the scale of Nature than the plant-lice, and one of them—the celebrated Cochineal—puzzled naturalists a long time as to whether it was a plant or an animal. There is in fact so much of the anomalous about this family that it furnishes a rich and interesting field of study.

The observations of both, Mr. Shimer, Mr. Walsh, and myself agreed as to the time of hatching; as to the mode of growth of the scale, and as to finding no females; but as to the process by which the scale was formed there was difference of opinion. The reason, it seems to me, is obvious enough: in attempting to elucidate the problem we reach beyond the limits of our power of perception into the realms of conjecture. It is easy enough to watch the mode of growth of an oak-apple, but it is not such an easy matter to ascertain the reason why the kind which occurs on the red oak (produced by *Cynips quercus-inanis*) should form inside with radiating spokes from a common central cell; while that on the black oak (produced by *Cynips? quercus-spongifica*) should form inside with a dense spongy substance around a similar central cell. Mr. Shimer may, in part, be right in stating that the larval scale is formed by the young louse shedding its skin; but the extremely fine skin alone would not form such a scale, and he strangely overlooks the wax-like filaments secreted from the general surface of the body as well as the peculiar distinction in the growth of the "medial" and "anal" sacks. That these two last scales are *constructed* by the louse, of its own cast skins and some excrementitious secretion, as he suggests, is also made *extremely* doubtful, from the simple fact that you may raise them every day of their growth and find the louse underneath, entirely free and separate. But after all, though of great scientific interest this matter is of no practical importance whatever, for as we shall see hereafter the great point to be borne in mind, in a practical light, is the time of hatching of the egg.

As the female Bark-louse is only capable of motion for a period of from two to three days at the most, after which time she becomes as permanently fixed for the rest of her life as is the tree on which she is fastened; and as the winged males (even if they ever exist) could not assist in the spread of the species, it may puzzle some to divine how this insect spreads from tree to tree and place to place. That it is transported to distant places, mainly on young trees, there can be no doubt, and there are various ways in which it can spread from tree to tree in the same orchard, though it can only thus spread during the few days of its active larval state. Mr. Walsh believes that the only way, as a general rule, that it can spread from tree to tree, when the boughs of those trees do not absolutely interlock, is by a few of these active young larvæ, crawling accidentally on to the legs of some bird, that chances to light on one tree and afterwards flies to another, and he even goes so far as to say that he believes this Bark-louse would soon cease to exist, if all the birds in the world were killed off (Rep. p. 41). My friend Walsh seems to have a special grudge against the birds, and it is hard to imagine how he could make such a statement, in face of the fact that where there is one bird, there are a hundred insects roaming constantly from tree to tree, that are just as capable of giving the young lice a lift. Moreover the specific gravity of the young louse is so slight that it almost floats in the air, and is undoubtedly aided in spreading by the winds; while on a tree very thickly covered with old scales, its traveling propensities are sufficiently developed to cause it to run down the trunk of the tree and *even over the ground*, and as it travels at the rate of two or three inches per minute, it could manage to measure several rods with its microscopic legs, in the course of its active state.

Though essentially belonging to the apple tree, this Muscle-shaped bark-louse is not unfrequently found both upon the Currant, the Plum and the Pear. I have seen the scales fully developed and bearing healthy eggs *on the fruit* of the White Doyenne pear, of the Transcendent crab, and of the wild plum (*Prunus Americana*) which have been sent to me by Mr. T. D. Plumb, of the State Journal, Madison, Wisconsin; and, though on the hard bark of a tree, we cannot judge of the amount of sap they absorb, it is quite apparent on these soft fruits, for each scale causes a considerable depression from the general surface. I have also received twigs of the Persian lilac from

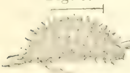
F. Starr, of Alton, Illinois, covered with a species, which, if not the same, is exceedingly like it.

Natural Remedies.—It was last year simultaneously discovered by Mr. Walsh and Mr. Shimer, that a species of mite (*Acarus* family) preyed unmercifully on the louse as well as on its eggs. This mite was described by Mr. Shimer as *Acarus malus* in the paper already referred to, and it appears that it greatly resembles the young bark-lice. Mites are not true insects, but belong to the same class (*Arachnida*) to which our spiders belong, and although the species are numerous—some causing galls on plants, some living externally on vegetable substances and seeds, either in a sound or rotten condition, others devouring animal substances, both dead and living, while others again are parasitic on certain animals—yet they all are readily distinguished in the perfect state from true insects by having four pairs of legs, and by the head and thorax being soldered in one piece without any joint whatever. Some of them, in the larval state, have but six legs, thus still more closely mimicking the young bark-lice, but they all acquire eight in the full grown state. This mite, so insignificant that in the larval state it can only be noticed by careful watching with a pocket-lens, has, doubtless, done more to save the apple trees in the Northern States than any one thing else; and its existence explains the gradual decrease of the Bark-louse that is known to have occurred in many orchards, and also accounts for its entire extermination on certain trees.

Fig. 4.

The next most efficient aid we have is the Twice-stabbed lady-bird (*Chilocorus bivulnerus*, Muls.) This good friend is readily recognized by its polished black color, and the blood-red spot on each wing-case. It is represented magnified at Figure 4, the hair line at the side showing the natural length. Its larva (Fig. 5) is a dark gray prickly affair, and is extremely active and voracious. In changing to pupa, the larval skin splits open on the back, but the naked pupa, which is of the color of burnt-umber with lighter sides, remains within it as if for protection. In this latter state these lady-birds may often be found fastened in clusters of from six to twenty on apple trees affected with either kind of bark-louse, and they should invariably be protected. It is astonishing how rapidly they will cleanse a tree from its vermin, and there is no better way of getting rid of bark-lice than by introducing a few of these little friends onto the lousy tree.

Fig. 5.



Artificial Remedies.—These may be summed up in a very few words, and consist, for the most part, in prevention, and I again urge a strict examination of every young tree before it is planted. If an orchard is once attacked before its owner is aware of it, much could be done on young tress by scraping the scales off in winter, but on large trees where it is difficult to reach all the terminal twigs, this method becomes altogether impracticable, and it will avail but little to cleanse the trunk alone, as most of the scales containing living eggs will be found on the terminal branches. Alkaline washes, and all other washes, except those of an oily nature, such as petroleum or kerosene, are of no avail when applied to the scales, for the simple reason that they do not penetrate and reach the eggs which are so well protected by these scales; and it is very doubtful whether any solution can be used that is sufficiently oily to penetrate the scales and kill the eggs without injuring the tree, especially while the sap of the tree is inactive. Hence, this Bark-louse can only be successfully fought at the time the eggs are hatching, and the young lice are crawling over the limbs. The time of year in which this occurs has already been indicated, and the trees should be closely watched during the last days of May and the first days of June, for, without close scrutiny, they will not be observed, appearing simply like very minute, white, moving specks. While the young larvæ are thus crawling over the tree, they are so tender that they can be readily destroyed by simply scrubbing the limbs with a stiff brush. It it quite evident, however, that any remedy, to become practicable on a large scale, so as to rapidly and effectually reach every limb of the tree, both large and small, must be applied by a syringe or by means of fumigation, and that whatever be applied, it must kill the lice without injuring the foliage or fruit, as the young apples are generally as large as a good sized pea by the time the lice hatch. Fumigation has not yet been sufficiently tried to enable us to judge of its merits. A correspondent of the *Prairie Farmer*, in recommending brimstone, gives the following as his plan of using it: "My plan is to cover the entire tree with cloth, so that there are no holes to let out the smoke; take an iron dish—a frying pan with a handle, if you please—put in about one pound of roll brimstone (not sulphur), heat a chunk of iron red hot—say a clock weight; drop the iron upon the brimstone, and put it under the tent cloth, where it should remain long enough to fairly smudge the whole tree. More brimstone can be added, and the iron repeated as often as desired, probably five minutes to a tree would be sufficient, more would do no harm. The cloth can be easily taken off and put on by two operators, each with a light pole with a spike in the end. The one pound of brimstone will burn about an hour." Having had no bark lice on which to try the above experiment, I wrote to the party recommending it, and as I received no answer, the experiment probably failed or was never tried. The brimstone would doubtless injure the tree.

Mr. A. R. Whitney, of Franklin Grove, Lee county, Illinois, whose apple trees have been troubled more or less with bark lice, found that an application of sheep manure around the trees, had a beneficial effect in checking the pests, and he attributes the result to the ammonia arising from the manure. With regard to washes, to be used with a syringe, the late Dr. Jno. A. Kennicott used 1 lb. of sal soda to one gallon of water with good effect; it is best used by heating o redness in an iron pot and then dissolving it in the water. Mr. E. G. Mygatt, of Richmond, McHenry county, Illinois, has experimented with this insect for over 20 years with the following result: Brine (2 quarts salt to 8 of water) kills the lice, but also the foliage and fruit. Tobacco water (strong decoction) neither injures the foliage nor affects the lice. A solution of cobalt kills the lice, but takes the foliage also. Weak lye kills the lice, but also somewhat affects the leaves. Lime water kills about half the lice, and affects the leaves a little. Finally, quassia, boiled in proportion of 1 pound to 3 gallons of water, though well known to be effectual for the common plant-lice, has no effect on these coccids. In short, we have abundant proof that neither tobacco-water nor strong alkaline washes have any effect on these young lice, though a strong solution of soap *will* kill them, and my experience the past season, with cresylic acid soap in other directions, leads me to strongly recommend it for this purpose. It will sometimes be necessary to repeat the wash, as the lice do not all hatch out the same day, though the period of hatching seldom extends over three days.

From the foregoing it is obvious that bark-lice can only be successfully fought during three or four days of the year: how absurd and ridiculous then, are all the patent nostrums and compounds which are continuously offered to the public as perfect "bark-lice extinguishers," and which never mention this most important fact. May this insight into the history of the Apple tree Bark lice, prevent many a man from being swindled out of his time and money by these impostors!

THE PERIODICAL CICADA.

(Homoptera Cicadidæ.)

SEVENTEEN AND THIRTEEN YEAR BROODS.

The year 1868 will long be remembered in the annals of insect life, as one of peculiar interest, from the fact that this singular Cicada (*Cicada septemdecim*, Linn.) popularly known as the "17-year locust," made its appearance very generally over the United States.

The metamorphoses of insects, their instructive industry, their quarrels and their instincts, afford abundant food for our love of the marvelous; but few of them can claim such a singular history as can our Periodical Cicada. We are moved to admiration in contemplating the fact that an insect, after living for 17 long years in the bowels of the earth, should at last change its sluggish, creeping and worm-like form, and, endowed with the power of flight, ascend from its earthy retreat to become a denizen of the air and to enjoy the full glory of the Sun. But our wonder increases when we reflect that this same insect has appeared in some part or other of the United States at regular intervals of 17 years, for centuries, aye! for ages in the past. Long ere Columbus trod on American soil this lowly insect must have appeared regularly at its appointed time. It must have filled the woods with its rattling song, when none but wild beasts and savages were present to hear it. To me there is something beautiful in the idea that through its periodicity we are enabled with tolerable certainty to go back in thought, for centuries in the past, to a particular month of a particular year, when the woods resounded with its song in the same manner as they did last summer; for so regularly do the different broods appear, that one is perfectly warranted in the assumption, that in the month of June, in the year 1738, for instance, 130 years ago—they appeared in the southern part of Missouri, and that 6 years previously they had appeared in the northwestern corner of the same State.

Though so much had hitherto been written about this Cicada, yet some of the most interesting facts with regard to it were unknown till the past season. A very complete article on the subject was published in the December number of the AMERICAN ENTOMOLOGIST, which I shall for the most part repeat, and render more complete by the addition of some facts as to their distribution, which were contained in some unpublished manuscript of the late Dr. Gideon B. Smith, of Baltimore, Md., and which were communicated to me through the kindness of Dr. J. G. Morris of the same city.

It was my good fortune to discover that besides the 17-year broods, the appearance of one of which was recorded as long ago as 1633, there are also 13-year broods;* and that, though both sometimes occur in the same States, yet, in general terms, the 17-year broods may be said to belong to the Northern, and the 13-year broods to the Southern States, the dividing line being about latitude 38°, though in some places the 17-year brood extends below this line, while in Illinois the 13-year brood runs up considerably beyond it. It was also exceedingly gratifying to find, four months after I had published this fact, that the same discovery had been made years before by Dr. Smith, though it had never been given to the world.

It so happened that one of the largest 17-year broods, together with one of the largest 13-year broods, appeared simultaneously in the summer of 1868. Such an event, so far as regards these two particular broods, has not taken place since the year 1647, nor will it take place again till the year 2089.

There are absolutely no perceptible specific differences between the 17-year and the 13-year broods, other than in the time of maturing; but whether or not, scientifically speaking, they are to be considered as specifically distinct, the 13-year brood may, for convenience sake, be called *Cicada tredecim*, in contradistinction to *Cicada septendecim*,

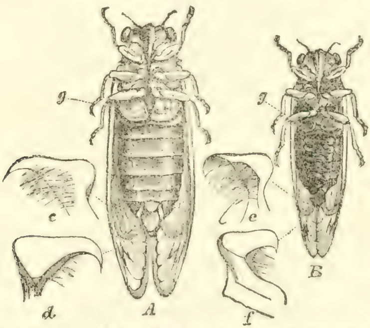
* See *Journal of Agriculture*, St. Louis, June 13, 1868, in which appeared the first account ever published of such a brood.

the 17 year brood. Mr. Walsh informs me that Charles Darwin, Prof. Asa Gray, and Dr. Hooker all agree in the belief that the 17-year and the 13-year forms ought not to be ranked as distinct species, unless other differences besides the period of development could be discovered, the mere rarity of variability in such a point not being sufficient.

TWO DISTINCT FORMS.

It is not a little singular, also, that two distinct forms occur in both broods—a large one and a small one—the former by far more numerous than the latter. This fact has been observed in past years, and was noticed the present year by independent observers in different parts of the country.† Indeed, it was observed by Dr. Hildreth, of Marietta, Ohio, as far back as 1830 (vide Silliman's Journal XVIII, p. 47). The true *Cicada septemdecim* of Linnæus (Fig. 6 *A*, ventral view of male), as described by Harris and Fitch, occurs in the greatest numbers, both in the 17 and 13-year broods. It will measure, on an average, one and a half inches from the head to tip of the closed wings, and almost always expands over three inches. The whole under side of the abdomen is of a dull orange-brown color, and in

[Fig 6.]



the male more especially, four or five of the segments are edged with the same color on the back.

The other form (Fig. 6 *B*, ventral view of male) is not, on an average, much more than two-thirds as large, and usually lacks entirely the dull orange abdominal marks, though there is sometimes a faint trace of them on the edges of the segments beneath. This small form was described in 1851, by Dr. J. C. Fisher, in the Proceedings of the "Philadelphia Academy of Natural Sciences," Vol. V, pp. 272-3, as a new species of

† 1. Mr. V. T. Chambers, in the August number of the "American Naturalist," p. 332, is said to point out some variation in color from those described by Dr. Fitch.

2. Mr. S. S. Rathvon favored me with specimens of both species from Lancaster county, Pa., accompanied with the following: "I am justified, I think, in concluding these are two distinct species. They are different in size and coloration, produce entirely different stridulation, do not cohabit indiscriminately," etc.

3. The correspondent to the Department of Agriculture (July Rep.) from Hematite, Mo., says: "There are two species, one (both male and female) about twice the size of the other, and differing greatly, also, in their cries and actions."

Cicada, hitherto confounded with *septemdecim*, and was named *Cicada cassinii.* His description was followed by a note from Mr. John Cassin, in which he states that the two forms show no disposition to associate together, and produce very different cries. The fact of the very great difference in the song of the males has been fully confirmed by the observations of M. C. Hill, of Northeast Ohio, who likewise found that the small form is very much less numerous than the large one.

The truest test of the specific distinction of these two forms lies in the comparative shape of the male genital hooks, and on submitting specimens of both forms to Dr. H. Hagen, of Cambridge, Mass., formerly of Köenigsburg, Prussia, he very kindly furnished the drawings *c*, *d*, *e*, and *f*, in Figure 6, which show the male genital hooks of both. That of *septemdecim* is represented on the outside at *c*, on the inside at *d*; and that of *cassinii* on the outside at *e*, and on the inside at *f*.

By these figures, it will be seen that there are sufficient differences to separate the two forms as distinct; but while the hooks of the large kind (*septemdecim*) are quite constant in their appearances those of the smaller kind (*cassinii*) are variable, and in some few specimens are undistinguishable from those of the large kind. This circumstance, coupled with the fact that the small kind regularly occurs with both the 17 and 13-year broods, would indicate it to be a dimorphous form of the larger, or true periodical species; especially when we consider that dimorphism and heteromorphism are not uncommon among the true Bugs (HEMIPTERA). Mr. P. R. Uhler, of Baltimore, Md., who has given this order of insects particular attention, informs me that he is not fully satisfied of the specific distinctness of *C. cassinii*; but Dr. Hagen thinks there is no possible doubt of its being distinct, for the simple reasons, as he states, that dimorphism occurs only in one sex, while here both sexes are involved; that *cassinii* appears later, makes a different noise, has different colors and was never seen to copulate with *septemdecim*. To use Dr. Hagen's own words, "what more is needed to make a distinct species, if one kind of Cicada requires 17 years to undergo its transformations, why not a second kind?" I find among a great number of specimen, which I have examined, that not only do the hooks of *cassinii* vary, but the other characters that have been mentioned as belonging to it, are variable, there being perfectly intermediate grades between its extreme type and that of *septemdecim*. Again, on the supposition that it is a distinct species, the chances are extremely small, of its issuing together with *septemdecim* in the *same* year in the many different localities hereafter mentioned. Therefore, though it will be convenient to use the two names, I think the two forms should not be ranked as distinct. But the discussion of the subject would involve the general problem of specific character.

The large species has been observed to make its appearance from eight to ten days earlier than the small species (*cassinii*), and there is not a single specimen of the latter, among a number of the 13-year brood (*tredecim*) that I captured in May, though I took a few specimens afterwards.

THE SEASON OF THEIR APPEARANCE AND DISAPPEARANCE

differs somewhat with the latitude, though not so materially as one might suppose. According to the records, they appeared the past season earlier in the South than in the North; but the last half of May can be set down as the period during which they emerge from the ground, in any part of the country, while they generally leave by the 4th of July. In St. Louis county the past season they commenced issuing on the 22d of May, and by the 28th of the same month, the woods resounded with the rattling concourse of the perfect insect. As is the case with a great many other insects, the males make their appearance several days before the females, and also disappear sooner. Hence in the latter part of the Cicada season, though the woods are still full of females, the song of but very few males will be heard.

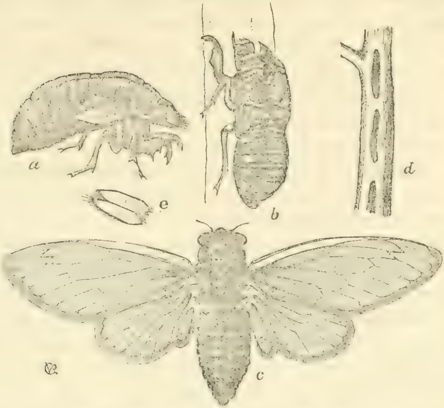
That circumstances favorable or otherwise may accelerate or retard their devolopment, was accidently proven, the past season, by Dr. E. S. Hull, of Alton, Illinois; as by constructing underground flues, for the purpose of forcing vegetables, he also caused the Cicadas to issue as early as the 20th of March, and at consecutive periods afterwards, till May, though strange to say these premature individuals did not sing. They frequently appear in small numbers, and more rarely in large numbers, the year before or the year after their proper period. This is more especially the case with the 13-year brood. Thus in Madison county in Illinois, and in Daviess and Clark counties in Missouri, there were in 1854 a few precursors to the true 1855 brood. They were also observed in Madison county, Illinois, in 1867; while "L. W." writing from Guntersville, Alabama, to the *Country Gentlemen* of June 25, 1868, says, "some call them 14-year locusts." Other such cases will be noticed hereafter.

THEIR NATURAL HISTORY AND TRANSFORMATIONS

have been sufficiently described in the standard works of both Harris and Fitch, and it is only necessary to mention a few facts not recorded by them.

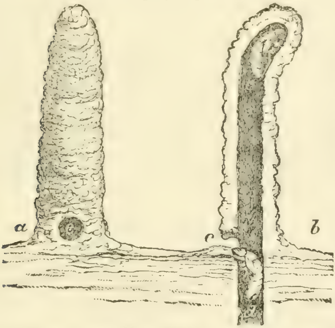
Mr. S. S. Rathvon, of Lancaster, Pa., who has himself witnessed four of their periodical visits, at intervals of 17 years, discovered the following very ingenious provision which the pupæ (Fig. 7, *a*) made the past season, in localities that were low or flat, and in which the drainage was imperfect. He says: "We had a series of heavy rains here about the time of their first appearance, and in such places and under such circumstances, the pupas would continue their galleries from four to six inches above ground (Fig. 8, *a* full view, *b* sectional

[Fig. 7.]



view), leaving an orifice of egress even with the surface (Fig. 8, *e*).—In the upper end of these chambers the pupas would be found awaiting their approaching time of change (Fig. 8, *c*). They would then back down to below the level of the earth, as at *d*, and issuing forth from the orifice, would attach themselves to the first object at hand and undergo their transformations in the usual manner." Mr. Rathvon kindly furnished me with one of these elevated chambers, from which the above drawings were taken. It measured about four inches in length, with a diameter on the inside of five-eighths of an inch, and on the outside of about one and a quarter inches. It was slightly bent at the top and sufficiently hard to carry through the mail without breaking. The inside was roughened with the imprints of the spines with which the fore legs of the builder are armed. In a field that was being ploughed near St. Louis, about the time of their ascent, I found that single, straight or bent chambers were the most common, though there were sometimes several branching near the surface from a main chamber below, each of the branches containing a pupa. The same observations have been made by other parties. These holes are cylindrical and are evidently made by oppressing the earth on all sides and throwing the refuse to the bottom, which must be quite a feat when they penetrate hard roads or come up between two rocks as they frequently do.

[Fig. 8.]



The larvæ are frequently found at a great depth, nothwithstanding its denial. Thus Mr. Henry Sadorus of Port Byron, Illinois, who built a house in 1853, found that they came up through the bottom of his cellar in 1854, the cellar being over five feet deep, and Mr. F. Guy of Sulphur Springs informed me that he had found them at a depth of ten feet below the surface.

When ready to transform they invariably attach themselves to some object, and, after the fly has evolved, the pupa skin is left still adhering, as shown at Figure 7 *b*. The operation of emerging from the pupa most generally takes place between the hours of 6 and 9 P. M.; and ten minutes after the pupa skin bursts on the back the Cicada will have entirely freed itself from it. Immediately after leaving the pupa skin, the body is soft and white, with the exception of a black patch on the prothorax. The wings are developed in less than an hour, but the natural colors of the body are not acquired till several hours have elapsed. These recently developed Cicadas are somewhat dull for a day or so after transforming, but soon become more active, both in flight and song, as their muscles harden. For those who are not informed of the fact, I will state that the males alone are capable of "singing," and that they are true ventriloquists, their rattling noise being produced by a system of muscles in the lower part of the body, which work on the drums under the wings, shown in Figure 6, at *gg*, by alternately tightening and loosening them. The general noise, on approaching the infested woods, is a compromise between that of a distant threshing machine and a distant frog pond. That which they make when disturbed mimics a nest of young snakes or young birds under similar circumstances—a sort of scream. They can also produce a chirp somewhat like that of a cricket's, and a very loud shrill screech, prolonged for fifteen or twenty seconds, and gradually increasing in force and then decreasing.

After pairing, the females deposit their eggs in the twigs of different trees; and though for this purpose they seem to prefer the oaks and the hickories, they oviposit in almost every kind of deciduous tree, and even in herbaceous plants, and in evergreens. We have seen their eggs in the Chestnut, Locust, Willow and Cottonwood, in peach twigs of not more than ¼ inch diameter, and also in the stems of the common Eupatorium, while R. H. Warder, of Cleves, Ohio, has found them in the following evergreens: Thuja occidentalis, Juniperus virginiana and Abies canadensis, but was unable to find any traces of their work in either of our common pines—Pinus Austriaca, P. strobus or P. sylvestris.

Dr. Harris (*Inj. Ins.* p. 212) has well described the mode of depositing, and it is only necessary to add that the female always saws with her head upwards, *i. e.* towards the terminal part of the branch, except when she comes in contact with a side shoot, when, instead of

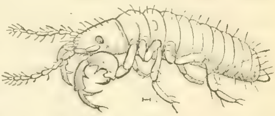
[Fig. 9.]

[Fig

shifting a little to one side, she reverses her position, and makes two punctures in an opposite direction to the rest, and thus fills up the straight row close to the base of the side shoot. The eggs (Fig. 7 *e*) are of a pearl white color, one-twelfth of an inch long, and taper to an obtuse point at each end. They are deposited in pairs, but separated by a strip of wood, which is wider —and thus causes the eggs to be further apart—at the bottom of the grooves than at their commencement. The punctured twigs bear the appearance of Figure 9, and frequently break off and die, though the great majority remain green and recover from their wounds. Indeed, there is every reason to believe that the eggs seldom hatch in those twigs which break off and become dry, but that the life and moisture of the twig is essential to their life and development of the egg, for the eggs are noticeably larger just before hatching than when first deposited, showing that they are, to a certain extent, nourished by the living wood, as is the case with those of many Saw-flies. Mr. Rathvon has also recorded the fact that the Cicada eggs are always shriveled in twigs that are amputated by the Oak-pruner (*Stenocorus villosus*, Fabr.) In the healing of the punctured parts a knot usually forms over each puncture, and I represent, at Figure 10, a portion of an apple twig, sent to me by Mr. John P. McCartney, of Cameron, in Clinton county, and which was punctured in the year 1862. Though the wounds had so well healed on the outside, the grooves inside were not filled up, but still contained the minute glistening egg-shells, from which the young larvæ had escaped six years before.

The eggs hatch between the 20th of July and the 1st of August or in about six weeks after being deposited. The newly hatched larva (Fig. 11) differs considerably from the full grown larva, but principally in having much longer and distinctly 8-jointed antennæ.* It is quite active, and moves its antennæ as dexterously and as rapidly as does an ant. As soon as it has extricated itself from an exceedingly fine membrane, which still envelops it after it has left the egg,† our little Cicada drops deliberately to the ground; its specific gravity being so insignificant, that it falls through the air as gently and as softly as does a feather.

[Fig. 11.]



The cross veins near the tip end of the upper wings of the Periodical Cicada form a dusky zig-zag mark in the shape of a W. Some ignorant persons are silly enough to believe that this mark portends

*There is frequently a ninth joint partly developed.

†All young Grasshoppers and Katydids that I have ever hatched were invariably enveloped in a like membrane after leaving the egg, and until this is thrown off the young insect is awkward in its motions. In the case of the young Cicada, these fine membranes are usually left attached to the roughened orifice of their nidus, and thus form, together, a white glistening bunch.

war. It occurs alike, though not to such a marked degree, on all other Cicadas, and if people must have an omen let them rather take the two W's for *warm weather*, and it will not be likely to disappoint them.

ENEMIES OF THE CICADA.

Upon leaving the ground to transform, the pupæ are attacked by different quadrupeds, by birds, by cannibal insects, such as Ground-beetles, Dragon-flies, Soldier-bugs, etc.; while hogs and poultry of all kinds greedily feast upon them. In the perfect fly state they are attacked by at least one insect parasite; for dipterous maggots (the larvæ, probably, of some Tachina fly) may occasionally be found in their bodies. In this state they are also often attacked by a peculiar fungus, which was first described by Dr. Leidy, in the Proceedings of the Philadelphia Academy of Natural Sciences for 1851. Dr. W. D. Hartman, of Westchester, Pa., speaking of the occurrence of this fungus, in 1851, says: "The posterior part of the abdomen, in a large number of male locusts, was filled by a greenish fungus. * * * The abdomen of the infected males was unusually inflated, dry and brittle, *and totally dead while the insect was yet flying about.* Upon breaking off the hind part of the abdomen, the dust-like spores would fly as from a small puff-ball." One male specimen received the present year from Pennsylvania was affected by the same, or a similar fungus, the internal parts of the abdomen being converted into what appeared to be a brown mould.

R. H. Warder, of Cleves, Ohio, in speaking of this mould says: It seemed to be a drying up of the contents and membranes of the abdomen, generally of a brown color, and dry and brittle. I found that in many cases the male organs of generation remained so firmly attached to the female during copulation that the male could only disengage himself by breaking away, leaving one or two posterior joints attached to the female, and it is these mutilated males which I found affected by the peculiar fungus mentioned, and therefore concluded that the "dry rot" might be the result of the broken membranes. I never found one thus affected in the very early part of their season, and I never found a perfect male thus affected. But this is not positive proof.

THE STING OF THE PERIODICAL CICADA.

It is astonishing what a wide-spread fear exists of the Cicada on account of its stinging powers. There is scarcely a paper in the United States but published some account of a "locust" sting last summer, while unpublished accounts were equally numerous. One of the editors of the St. Louis *Republican* was kind enough to clip out for me all accounts of such stings, which he found in their numerous exchanges, and the number which had accumulated, before the end of the "Locust" season, was truly surprising. Some people even denied themselves the pleasure of eating blackberries, raspberries and other fruits, because they feared these fruits had been poisoned by the eggs of Cicadas; while others believed that they poisoned water. I have endeavored to trace up a number of these reports, but have invariably found that they were either false or greatly exaggerated, and there is no doubt whatever that the great majority of such accounts owe their origin to the fertile imaginations of newspaper reporters, who are ever ready to create a sensation. Yet, to use a common metaphor, it is strange there should be so much smoke and no fire, and I will briefly review the only three methods by which such stinging can possibly be produced. At the same time, I give it as my conviction that there is but little cause for fear, as I have handled hundreds of them, and know hundreds of persons, including children, who have done the same, and yet have never been able myself to witness a single case of *bona fide* stinging,

BY HORNETS.—There is a very large Digger wasp (*Stizus grandis*, Say), represented of the natural size in the accompanying Figure 12,

[Fig. 12.]

whose peculiar habit it is to provision its nests with Cicadas. The burrows made by this Digger wasp, or hornet, are about three feet long, with two or three galleries about one foot long, each terminating in a chamber considerably enlarged. The female catches a Cicada which she stings and paralyzes, and drags into one of these chambers; and it is not very unlikely that she should occasionally alight on some human being with a Cicada in her grasp, and upon being brushed off, should retaliate by stinging the offender, and then fly off, leaving the Cicada behind, which, in absence of the hornet, would very naturally be accused of the sting. An allied species of Digger wasp (the *Stizus speciosus* of Say) has been actually observed, by Mr. Rathvon, to carry off a few belated individuals of the Periodical Cicada; but the usual prey of both these species is the larger annual Cicada (*C. pruinosa*, Say), and they both occur too late in the season to be the cause of all the stinging we hear of.

BY THE OVIPOSITOR.—The ovipositor of the female (Fig. 13, *b*) is certainly capable of inflicting a wound, but the Cicada is anything but pugnacious, and when not in the act of ovipositing, this instrument is securely enclosed in its sheath. That this is the stinging instrument is rendered extremely doubtful, for the following reasons: 1st. All the stinging we hear of has been done suddenly, while the insertion of the ovipositor would necessarily be a gradual operation, requiring at least one minute; 2d. The real function of the ovipositor is to convey an egg into the wound which it makes, and I have been unable to trace a single case where eggs were found in the flesh. All such accounts have proved to be fabrications, and the straightforward report which Mr. V. T. Chambers, of Covington, Ky., gave inthe August number of the *American Naturalist*, of a negro being stung on the foot by a Cicada, proved, after all, to be a mistake, for "Mr. Winston did not see the insect with its instrument *in situ*;" 3d the three following facts, which are reliable, prove that stinging in the usual sense of the term, by this instrument is almost impossible: First, Mr. Wm. Muir, associate editor of Colman's *Rural World*, carefully lifted a female from off a tree, while she was yet in the act of ovipositing, and as carefully placed her on his little finger, holding it as near as possible in the same direction and position as the branch grew from which she was taken. She instinctively endeavored to continue ovipositing, and, holding firmly to his finger, tried again and again to insert the ovipositor, but without the least success, for it could not make the least impression on the soft and yielding flesh, but continually slipped from one side to the other. Second, it is recorded that Mr. Peter A. Brown, of Philadelphia, Pa., himself inflicted a puncture with the ovipositor, several times, upon his hand, without experiencing any more pain than that produced by a prick of a pin or any other pointed instrument, and that no swelling ensued; third, Dr. Hartman, of Pennsylvania, introduced some of the moisture from the ovipositor into an open wound and it caused no inflammation whatever.

[Fig. 13.]

By the Beak, or Haustellum.—The beak (Fig. 13, *a*) is an organ which both sexes of the Cicada possess, and by which they take their nourishment. I have seen them insert it into and extricate it from the branches of different trees, and know that the operation is quite rapid, and that the instrument must be quite sharp and strong. All the more authentic cases of stinging, indicate this to be the instrument,* and it is quite likely that, just as the sting of a bee will affect some persons nigh unto death, and have no effect whatever on others, so the puncture of the beak of a Cicada will be more serious with some than with others. That there is no poison

*Mr. D. B. Wier, of Lacon, Ills., who well knows the difference between the male and female Cicada, recollects distinctly, that when they were there in 1854, he was stung in the finger by the male, the sting not causing very severe pain.

Mr. R. T. Parker, of St. James, Phelps county, Mo., an intelligent fruit grower, who has given some time to the study of insects, informed me that he was stung on the neck by a male Cicada, evidently with the beak, and that the sting was not so painful as that of a bee.

Dr. M. M. Kenzie, of Centerville, Reynolds county, Mo., has communicated the fact that Frank Smith, aged 14 years, living on Henpeck, in the lower part of Reynolds county, was stung by a Cicada on the back of the left hand. The wound healed by first intention, and the next morning there was only a black clot, *about the size of a pin's head,* to mark its place, with scarcely any swelling.

gland attached to this beak, is no argument against its stinging power for several true Bugs are known to produce severe stings by their beaks, while the hairs and spines of some caterpillars have a similar power.

THE INJURY WHICH CICADAS CAUSE TO FRUIT TREES.—REMEDIES.

While living under ground they have been accused of killing pear trees, and more especially by Miss Margaretta H. Morris, in accounts of them published in 1846. The late Dr. Smith, of Baltimore, however, who made extensive operations, denied their being capable of such injury. He says:

"The larva obtains its food from the small vegetable radicals that everywhere pervade the fertile earth. It takes its food from the surface of these roots, consisting of the moist exudation (like animal perspiration), for which purpose its rostrum or snout is provided with three exceedingly delicate capillaries or hairs which project from the tube of the snout, and sweep over the surface, gathering up the minute drops of moisture. This is its only food. The mode of taking it can be seen by a good glass."—*In Prairie Farmer, December*, 1851.

While they can, if they wish, insert their beaks into roots, and very likely do so in some cases, yet I incline to believe, that Dr. Smith's views are correct, for though Dr. Hull, of Alton, Illinois, has often found them firmly attached to different roots by the legs, he has never found the beaks inserted. The fact that they will rise from land which has been cleared of timber, cultivated, and even built upon for over a dozen years, certainly contravenes Miss Morris's statement, while their long subterranean existence precludes the necessity of rapid suction. It is also quite certain that if they thus killed trees, we should oftener hear of it, and I have captured a gigantic but unnamed species of Cicada on the plains of Colorado, 50 miles from any tree, other than a few scattering willows.

In the perfect state, however, the female is capable of doing great injury to trees by hacking up their twigs, in the process of depositing, and although their injury in the forest is not generally felt, it is a very different thing in our orchards, and especially in the nursery.

The following editorial from the old *Valley Farmer* of November, 1855, will show how serious the injury may sometimes be:

"We planted an orchard of the best varieties of apple trees last spring. We had taken particular pains, not only in selecting the best varieties, but in planting the trees, and hoped in a few years to partake of the fruit. But our hopes were destined to be blasted. The locusts during the summer destroyed nearly all of them; not one in six is living. To look at them one would think that some person had been drawing the teeth of a saw over the bark of every tree."

It also appears that in some instances they injure trees by the insertion of their beaks for nourishment, for Mr. Gustavus Pauls, of Eureka, had a young apricot tree which was so thoroughly punctured in this manner, that he took a gallon of coajulated sap from it, and he attributes the death of some of his trees to this cause. I am convinced, however, that the injury done in this manner is comparatively trifling.

On the 13th of June I was sent for by four different parties in St. Louis county, who wished me to try and save their trees from the ruinous work of these cicadas, which had by this time began to deposit their eggs in real earnest. I found that when the wind was high they could, by its aid, be driven to some extent, but that without its aid they could not be driven at all; as when started, they are just as likely to fly behind as before you. I tried lye, whitewash and sulphur, air-slacked lime and finally carbolic acid, and found that none of these mixtures would affect them. Indeed, after experiments involving about $200, I am convinced that there is no available way of entirely preventing this ruinous work when they once commence to deposit. The nursery of Mr. Stephen Partridge, a few miles west of St. Louis, which is surrounded on all sides by timber, was more seriously injured than any other which I saw, and he lost many hundred dollars' worth of apple, peach and pear stock. They also punctured his grape vines very freely, preferring the Clinton and Taylor among varieties. By having all hands turn out early in the morning, and between six and seven o'clock in the evening, while they hung listlessly to the branches, he succeeded in crushing thousands of them, and thus saved parts of his nursery from total ruin. But it becomes a hopeless task to try to stay their disastrous work when once they have acquired full power of flight; though, while in their feeble and helpless condition, as they leave the ground, they can not only be destroyed to far greater advantage by human agency, but hogs and poultry of all kinds, eagerly devour them. There were, it is true, many accounts afloat last summer of hogs being poisoned by them, and, though it is not impossible that one was occasionally killed by over-glutting,* such cases were very rare indeed. From the foregoing, the importance of knowing beforehand when to expect them becomes apparent, and the following chronological table, will not only prove of great scientific interest but of practical value. In the greater part of Missouri, the fruit grower may rest from all anxiety as to their appearance for thirteen years to come, but in the month of May, 1881, let him look out for them.

THEIR CHRONOLOGICAL HISTORY, WITH PREDICTIONS OF THE FUTURE APPEARANCE OF ALL WELL ASCERTAINED BROODS THROUGHOUT THE COUNTRY.

As nothing had been published up to A. D. 1868, as to the regular appearance of any thirteen year broods of Cicadas, it is not at

* Mr. F. R. Allen, of Allenton, informs me that during years when the army worm (*Leucania unipuncta*, Haw.) occurred in such swarms, hogs and chickens feasted on them to such an extent that the former frequently died, while the latter laid eggs in which the parts naturally white would be entirely green when cooked.

all surprising that errors were committed by former writers on the subject. In the following chronology of this insects periodical visits, everything heretofore published has been revised as far as possible. The mass of facts from which the generalizations are made would be tedious if given in detail, and are therefore for the most part omitted. This chronology could not, of course, be made complete from a single season's researches, and it may even contain errors, but it will remain as a foundation for future work, and before another seventeen years shall have passed away, we may hope to have this part of the history of our curious Cicadas completed and perfected.

While the discovery of the thirteen year broods, dispelled much of the fog in which this chronology had hitherto been wrapped, it at the same time, rendered a complete and lucid exposition of that chronology extremely difficult. The northern boundary line of the thirteen year broods is about latitude 37°, but in Illinois one of them ascends between two and three degrees above this line, while the seventeen year broods descend below it in several places, the two broods sometimes occupying the Carolina. Thus the two broods sometimes occupy the same territory; while two broods of the same kind, appearing in different years may also overlap one another, as in the instance given in the account of brood XXII in Virginia, where the "locusts" appear every eighth and ninth year. In order to make the subject as clear as possible, and to facilitate references, I have numbered the different broods of this insect in accordance with the date of their future appearance from and after the present year.

BROOD I.—*Septemdecim*—1852, 1869.

In the year 1869, and at intervals of seventeen years thereafter, they will, in all probability, appear in the valley of the Connecticut river. According to Dr. Asa Fitch (N. Y. Rep. I, p. 40), they appeared there in 1818 and 1835, and according to Dr. Smith they occurred in Franklin, Bristol and Hampshire counties, Massachusetts, in 1767, '84, 1801, '18, '35 and '52.

BROOD II.—*Tredecim*—1856, 1869.

In the year 1869, being the same as the preceding, they will in all probability appear in Georgia, in Habersham, Rabun? Muscogee, Jasper, Greene, Washington and adjacent counties, having appeared there in 1843 and 1856, according to Dr. Smith.

BROOD III.—*Septemdecim*—1853, 1870.

In the year 1870, and at intervals of seventeen years thereafter, they will in all probability appear in what is known as the "Kreitz Creek Valley" in York county, Pa., and possibly in Vinton county, Ohio, and Jo. Daviess county, Ills. Mr. S. S. Rathvon, of Lancaster, Pa., speaking of this brood, says: "Lancaster county is bounded on the southwest by the Susquehanna river, dividing it from the county of York, along the northeastern margin of which there is a mountain range, sloping down to the river. Along that slope Cicadas were abundant the present season (1868—Brood XXII). But on the southwest side of the range, in what is known as the Kreitz Creek Valley, there were none. They appeared last in this valley in 1853, and previous to that year at intervals of seventeen years from time immemorial." Dr. Smith records their appearance in 1853, both in Vinton county, Ohio, and Jo. Daviess county, Illinois.

BROOD IV.—*Tredecim*—1857, 1870.

In the year 1870, being the same as the preceding, they will in all probability appear in Jackson, Gadsden and Washington counties, Florida, having appeared there according to Dr. Smith in 1844 and 57.

BROOD V.—*Septemdecim*—1854, 1871.

In the year 1871, and at intervals of 17 years thereafter, they will in all probability appear around the head of Lake Michigan, extending as far east as the middle of the State of Michigan, and west an unknown distance into Iowa. Also in Walworth county and other portions of Southern Wisconsin, and southward into Illinois. This brood is equal to Dr. Fitch's 6th. It extends all over Northern Illinois, and as far south as Edgar county, and its appearance in 1837 and 1854 is well and thoroughly recorded. In Champaign county, Ills., it overlaps Brood XVIII, or the Southern Illinois *tredecim* brood, while it also interlocks with Brood XIII (*septemdecim*) in the same county.

They will also appear in the same years in the southeast by eastern part of Lancaster county, Pa., in what is called the "Pequea Valley," having appeared there in vast numbers in 1854.

The earliest known record we have of the appearance of periodcal Cicadas, is in Morton's "Memorial," in which it is stated that they appeared at Plymouth, Plymouth county, Mass., in the year 1633.—Now, according to that date, one might be led to suppose that this recorded brood of Morton's belonged to this Brood III, as exactly 14 periods of 17 years will have elapsed between 1633 and 1871; but, strange to say, we have no other records of his brood than that in the "Memorial," whereas there are abundant records of their appearing one year later in the same locality, ever since 1787. There is therefore good reason to believe that the visit recorded by Morton was a premature one, and that it was properly due in 1634. I have therefore placed it in Brood XIII, and have little doubt but that if records could be found, these would prove the Cicadas to have appeared in 1651, 1668, 1685, 1702, 1719, 1736, 1753, and 1770, as they did in 1787, 1804, 1821, 1838, and 1855.

BROOD VI.—*Tredecim*—1858, 1871.

In the year 1871, being the same year as the preceding, and at intervals of 13 years thereafter, they will in all probability appear in the extreme southwestern corner of Mississippi, and in the adjoining part of Louisiana. Dr. D. L. Phares of Newtonia (near Woodville), Miss., says that in 1858 they extended over most of Wilkinson and part of Amite counties, Mississippi, and East and West Feliciana, La. He has himself witnessed the appearance of this brood during the years 1832, 1845 and 1858, while it is distinctly remembered by aged people in his neighborhood as having also appeared there in the years 1806 and 1819. Dr. Smith gives their range from the Mississippi river, east to a ridge 45 miles from the river that divides the State, north and south, and north and south to the boundaries of the State; recording them as occurring in 1806, '19, '32, '45 and '58.

BROOD VII.—*Tredecim*—1859, 1872.

In the year 1872, and at intervals of 13 years thereafter, they will in all probability appear in Jackson county and around Cobden and Jonesboro, in Union county, South Illinois, in Kansas, Missouri, Georgia, Louisiana, Tennessee and Mississippi.

According to Mr. Paul Frick of Jonesboro, they were in Union county, Ills., in 1858, and he also thinks it was a great year for them *about* 1832. Those of 1858 were probably premature stragglers of the 1859 brood, while Mr. Frick is most likely mistaken as to the year 1832, since the Rev. George W. Ferrell of Cobden, Union county, witnessed their appearance at that place in 1833, and also in 1846 and 1859; and Cyrus Thomas has also recorded their appearance in 1859 in the 5th Rep. of the Ills. State Agr. Soc., p. 458*, while a paragraph in the Baltimore (Md.) *Sun* of June 13, 1859 says "the locusts have made their appearance in 'Egypt' in Southern Illinois, and cover woods and orchards in swarms." This brood not improbably extends westward into Missouri, for several of the old settlers around Eureka, in St. Louis county, Mo., recollect it being "locust year" about the time of its last appearance, while Mr. L. D. Votaw of Eureka, and Wm. Muir of Fox Creek, Mo., both believe it was exactly 9 years ago, or in the year 1859. Dr. Smith records it in DeKalb, Gwinnett and Newton counties, Georgia, in 1846 and '59; in the northern part of Tennessee also, in 1846 and '59; in the whole eastern portion of Mississippi from the ridge which is 45 miles from the river, on the west, to the eastern boundary, in 1820, '33, '46, and '59; in Carrol Parish, Louisiana, in 1859; and in Philips county, Kansas, in the same year.

By referring to Brood XV, it will be seen that in 1846, or during the first year of the Mexican war, this 13-year brood appeared simultaneously with a 17-year brood in western Pennsylvania and Ohio.

* If Mr. Paul Frick is correct, the brood he has witnessed may possibly be a detachment of the Mississippi and Louisiana Brood VI; in which case the Cicadas appear for two consecutive years in Union county, Ills., as they do (See Broods XIII and XIV) in Central Ohio, and portions of Northwestern Missouri.

BROOD VIII.—*Septemdecim*—1855, 1872.

In the year 1872, being the same year as the preceding, and at intervals of 17 years thereafter, they will, in all probability, appear in the southeastern part of Massachusetts; across Long Island; along the Atlantic coast to Chesapeake Bay, and up the Susquehanna at least as far as to Carlisle in Pennsylvania; also, in Kentucky, at Kanawha in Virginia, and Gallipolis, Ohio, on the Ohio river. This is the brood referred to in Brood V, and which there is every reason to believe is the one recorded by Morton in his "Memorial," as occurring in 1633.

Dr. Fitch, in the account of his 3d brood (N. Y. Rep. I, p. 39), says: "The third brood appears to have the most extensive geographical range. From the southeastern part of Massachusetts, it extends across Long Island, and along the Atlantic coast to Chesapeake Bay, and up the Susquehanna at least as far as to Carlisle in Pennsylvania; and it probably reaches continuously west to the Ohio, for it occupies the valley of that river at Kanawha in Virginia, and onwards to its mouth, and down the valley of the Mississippi probably to its mouth, and up its tributaries, west, into the Indian Territory. This brood has appeared the present year, 1855, and I have received specimens from Long Island, from South Illinois, and the Creek Indian country west of Arkansas," etc.

There is every reason to believe that Dr. Fitch, in this account, has confounded this *septemdecim* Brood VIII, with the great *tredecim* Brood XVIII, for it so happened that they both occurred simultaneously in 1855, but the exact dividing line of these two broods is not so easily ascertained. Certainly, after reaching the Ohio river, the *septemdecim* brood extends beyond Gallipolis, Ohio, for Prof. Potter, in his "Notes on the Cicada decem septima," records their appearance at that place in 1821; and Dr. Smith records their appearance at Frankfort, Lexington and Flemingsburg, Kentucky, in 1838, and 1855. But I strongly incline to believe that well nigh the rest of the territory mentioned by Dr. Fitch was occupied by the *tredecim* brood, the reasons for which belief will be found in the account of brood XVIII.

Cicadas also appeared in Buncombe and McDowell counties, North Carolina, in 1855, but until they appear there again it will be impossible to say, positively, whether they belong to this *septemdecim* Brood VIII, or to the *tredecim* Brood XVIII.

BROOD IX—*Septemdecim*—1857, 1874.

In the year 1874, and at intervals of 17 years thereafter, they will propably occur in southeast Nebraska.

The occurrence of this brood was communicated to me by Mr. Clarke Irvine, of Oregon, Holt county. The brood is most likely confined to the eastern or timbered portion of the State, and I judge it to be *septemdecim*, from the fact that the latitude is rather more northerly than tredecim is known to occur.

BROOD X—*Tredecim*—1862, 1875.

In the year 1875, and at intervals of 13 years thereafter, they will most likely occur in different parts of Texas. According to Dr. Smith they appeared in vast numbers in some parts of Texas in 1849, though he was not able to get any particulars.

BROOD XI—*Septemdecim*—1859, 1876.

In the year 1876, and at intervals of 17 years thereafter, they will in all probability appear in parts of North Carolina, Virginia, Maryland, Illinois and Indiana. According to Dr. Smith they appeared from Raleigh, North Carolina, to near Petersburg, Virginia, in 1842 and 1859; in Rowan, Davie, Cabarras and Iredell counties in the same State in 1825, 1842 and 1859; in the valley of Virginia as far as the Blue Ridge on the east, the Potomac river on the north, the Tennessee and North Carolina lines on the south, and for several counties west, in 1808, 1842 and 1859; in the south part of St. Mary's county, Maryland, dividing the county about midway east and west, in 1825, 1842 and 1859; in Illinois about Alton in 1842 and 1859; and in Sullivan and Knox counties, Indiana, in 1842 and 1859.

BROOD XII—*Septemdecim*—1860, 1877.

In the year 1877, and at intervals of 17 years thereafter, they will, in all probability, appear in the vicinity of Schuylerville and Fort Miller, in New York. From thence along both sides of the Hudson to its mouth, where they extend, at least, to New Haven, in Connecticut, and west across the north part of New Jersey and into Pennsylvania. Also in Dearborn county, Indiana; Kalamazoo, Michigan; in Pennsylvania, North Carolina, Virginia and Maryland.

This brood is recorded by Prof. Potter as having occurred at North Haven, Conn., in 1724, 1741, 1758, 1792, 1809 and 1826. It was also recorded by the same writer as having occurred in 1826 in Middlesex county, N. J., and by Dr. Fitch as having occurred in 1843 throughout the whole country mentioned above. In 1860, again, it was spoken of in the old series of the *Prairie Farmer* (Vol. 22, p. 119) as having occurred that year in New Jersey, and Dr. Smith records it throughout the whole State in 1775, 1792, 1809, 1826 and 1843. Mr. Jas. Angus, of West Farms, Westchester county, N. Y., has himself witnessed its recurrence in the years 1843 and 1860.

In Pennsylvania, Mr. Rathvon found a few individuals in 1860, and Dr. Smith says it extends from the Susquehanna to the Delaware river, bounded by Peter's mountain on the south. In Virginia it occurred from the south part of Loudon county to the Roanoke river, and from the Blue Ridge to the Potomac in 1826, 1843 and 1860. In Maryland from Ann Arundel county to the north part of St. Mary's, and from the Potomac to Chesapeake Bay, in 1809, 1826, 1843 and 1860. In Rockingham, Stokes, Guilford, Rowan, Surrey and adjacent counties, North Carolina, in 1792, 1809, 1826 and 1843. In Dearborn county, Indiana, in 1843 and in 1860, and in Kalamazoo, Michigan, during the same years.

BROOD XIII.—*Septemdecim*—1861, 1878.

In the year 1878, and at intervals of 17 years thereafter, they will, in all probability, appear along the centre of the State of Illinois, all along the southern part of Iowa, and around St. Joseph, in Buchanan county, in North Missouri.

The records are abundant, of their appearance, in 1844 and 1861, all along the southern border of Iowa, and in Mason, Fulton, McDonough and Champaign counties in Central Illinois. In 1861 they also occurred in Champaign county, Central Ohio, and in Buchanan county, Northwest Missouri; and this brood not unlikely occupies, more or less, the whole strip of country between these two points. Their appearance in 1861 was associated with the first year of the rebellion; and Dr. Smith records this brood both in Illinois and Iowa in 1844.

BROOD XIV.—*Septemdecim*—1862, 1879.

In the year 1879, and at intervals of 17 years thereafter, they will, in all probability, appear in the whole of western Missouri, commencing south about Johnson and Saline counties, and extending in a northwesterly direction to Lawrence and above, in Kansas, south to Arkansas, and west an unknown distance into Kansas; also, in Central Ohio.

The occurrence of this brood in 1845 and 1862 is well remembered by several of my correspondents, and is recorded by Dr. Smith. At St. Joseph, in Buchanan county, Mo., Cicadas were not so thick in 1862 as in 1861. Had it been the reverse, or, in other words, had they been more numerous in 1862 than in 1861, I should have been inclined to record the visit of 1861 as but a precursor to this Brood X; but as it is, I believe the two broods are distinct, and that they occur for two consecutive years, both in Central Ohio and in portions of Northwest Missouri.

This brood has not been traced further east, in Missouri, than Saline county, and yet a detachment of it certainly occurs in Ohio, for Mr. Clarke Irvine, of Oregon, Holt county, Mo., well remembers their occurrence in Central Ohio in 1845 and 1862. Though there is no knowledge of the appearance of this Brood XIV in Illinois, yet the fact of its occurring both in Ohio and in North Missouri, and that, too, but one year after Brood XIII, would indicate that there may have been, in times past, at all events, if there is not at the present day, a geographical connection between these two broods.

BROOD XV.—*Septemdecim*—1863, 1880.

In the year 1880, and at intervals of 17 years thereafter, they will, in all probability, appear from western Pennsylvania to Sciota river, east, and down the valley of the Ohio river as far as Lewis county, in Virginia.

This brood is recorded in Ohio as far back as the year 1812, by "A. M. B.," writing to the Chicago *Tribune*, under date of June 22, 1868. Harris also records its appearance in Ohio in 1829, and they were quite numerous in Coles county, in the centre of the same State in 1846, or during the first year of the Mexican war, while Dr. Smith records it in the eastern part of the State, extending over twelve counties, west, to the Sciota river, and to Sandusky, on Lake Erie, in 1829, '46 and '63; and in Lewis county, Virginia, since 1795. As before stated this brood occurred in Ohio in 1846, simultaneously with the *tredecim* brood VII in South Illinois. Dr. Fitch, in his account of his 5th brood, also records its appearance, and states that it reached to Louisiana. But just as the *septemdecim* Brood VIII was confounded with the great *tredecim* Brood XVIII in 1855, so this *septemdecim* Brood XV was doubtless also confounded with it in 1829, for they both occurred that year. Had the western country been as thickly settled in 1829 as it was in 1855, the *tredecim* Brood XVIII could undoubtedly have been traced in Southern Illinois and Missouri, etc., in the former as it was in the latter year. This belief is furthermore greatly strengthened from our having no other record of the appearance of this *septemdecim* brood, in Louisiana, than Prof. Potter's statement that they appeared there in 1829, whereas they have occurred there since 1829 at intervals, not of 17, but of 13 years, and were there the present year, 1868, as will be seen on referring to Brood XVIII. The dividing line of these two broods (XV and XVIII) is probably the same as with broods VIII and XVIII.

BROOD XVI.—*Tredecim*—1867, 1880.

In the year 1880, being the same as the preceding, they will, in all probability, appear in the north part of Cherokee county, Georgia, having appeared there according to Dr. Smith in 1828, '41, '54, and according to Dr. Morris, in 1867. This brood occurred in 1867 simultaneously with the northern *septemdecim* brood XXI.

BROOD XVII.—*Septemdecim*—1864, 1881.

In 1881, and at intervals of 17 years thereafter, they will, in all probability, appear in Marquette and Green Lake counties, in Wisconsin, and may also appear in the western part of North Carolina, and about Wheeling, Virginia; in Northeast Ohio, and a few in Lancaster county, Pa., and Westchester county, New York.

There is abundant evidence that they appeared in the counties named in Wisconsin in 1864, and fair evidence that they appeared that year in Summit county, Northeast Ohio, while straggling specimens were found in the same year, by Mr. S. S. Rathvon, in Lancaster county, Pa., and by Mr. James Angus, in Westchester county, N. Y. Dr. Fitch also records their appearance in 1847, or 17 years previously, in the western part of North Carolina, and Dr. Smith, in Wheeling, Virginia, in 1830, '47 and '64. The distance between the localities given is very great, and it is doubtful whether all these records belong to one and the same brood.

BROOD XVIII.—*Tredeim*—1868, 1881.

In the year 1881, and at intervals of 13 years thereafter, they will, in all probability, appear in Southern Illinois, throughout Missouri, with the exception of the northwestern corner, in Louisiana, Arkansas, Indian Territory, Kentucky, Tennessee, Mississippi, Alabama, Georgia, and North and South Carolinas.

Though, as already stated, I published the first account ever given of the existence of a 13-year brood, yet, besides the others mentioned in this chronology, this particular brood has been traced since, as having occurred in the years 1816, '29, '42, '55 and '68; and Mr. L. W. Lyon, at the July (1868) meeting of the Alton, (Ills.) Horticultural Society, even mentioned its appearance in 1803.

In Missouri, it occurs more or less throughout the whole State with the exception of the northwest corner that is bounded on the east by Grand river, and on the south by the Missouri river.* The southeast part of the State, where Dr. Smith has recorded it since 1829, is most thickly occupied. I enumerate those counties in which there is undoubted evidence of their appearance during the present year (1868) viz.: Audrain, Bollinger, Benton, Clarke, Chariton, Callaway, Cooper, Cole, Franklin, Gasconade, Iron, Jefferson, Knox, Lewis, Marion, Macon, Morgan, Moniteau, Pike, Phelps, Pulaski, Polk, Pettis, Schuyler, St. Charles, St. Louis, St. Francois, St. Clair, Warren, and Washington.

It not improbably overlaps some of the territory occupied by the *septemdecim* Brood XIV, but I do not think it extends into Kansas.

In Illinois it occurs more or less throughout the whole southern half of the State, but more especially occupies the counties from the south part of Adams county along the Mississippi to the Ohio, up the Ohio and Wabash rivers to Edgar county, and then across the centre of the State, leaving some of the central counties in South Illinois unoccupied. To be more explicit, I enumerate all the counties in which it undoubtedly occurred during the present year (1868): Adams (south part, back of Quincy), Bond, Clinton (northwest corner, adjacent to Madison), Champaign, Coles, Crawford, Cumberland, Clay, Clark, Edwards, Edgar† (especially in the eastern part), Franklin, Gallatin, Hardin, Hamilton, Johnson, Jasper, Jersey, Jefferson, Lawrence, McLean (east end), Macon, Madison, Marion, Massac, Monroe,

*As Mr. Wm. Raucher, of Oregon, Holt county, saw a few individuals in the northeast part of Buchanan county in 1855, it may occur in small numbers in districts even north of the Missouri river.

† Edgar county also has the *septemdecim* Brood III.

Pike, Perry, Piatt, Pope, Richland, Randolph, Sangamon, Saline, St. Clair, Union (northeast corner), Washington, Wayne, Wabash, Williamson and White. There were none the present year, either at Decatur, in Macon county, or at Pana in Christian county; nor were there any at Bloomington or Normal, in McLean; nor in Dewitt county, which lies south of McLean; nor in Spring Creek, Iroquois county, which is northeast of Champaign.

In Kentucky, according to Dr. Smith, it occurred in the northwest corner of the State, about Paducah and adjacent counties south, in 1829, '42, and '55, and it occurred there in 1868.

In Arkansas, it occupied all the northern counties in 1842, '55 and '68.

In Alabama, it occupied Russell and adjacent counties on the east side of Black Warrior river, in 1842, '55 and '68.

In Tennessee, it occupied Davidson, Montgomery, Bedford, Williamson, Rutherford and adjacent counties in 1842, '55* and '68.

In North Carolina, it appeared in Mecklenburg county, in 1829, '42, '55 and '68.

In South Carolina, the Chester district and all the adjoining country to the Georgia line, west, and to the North Carolina line, north, was occupied with it in 1816, '29, '42, '55 and '68.

In Georgia, it has occurred in Cherokee county since the year 1816.

In Louisiana, it appeared in Morehouse, Caddo, Clairborne, Washington and adjacent parishes, in 1855 and '68.

It also doubtless occurs in Mississippi and Indian Territory, though I am unable to specify any localities.

BROOD XIX.—*Septemdecim*—1865, 1882.

In the year 1882, and at intervals of 17 years thereafter, they will, in all probability, appear in Monroe, Livingston, Madison and adjacent counties, and around Cayuga Lake, in New York.

Mr. T. T. Southwick, of Manlius, Livingston county, records their appearance there in 1865, and, as will be seen by referring to the *Prairie Farmer*, vol. 16, p. 2, they appeared during the same year near Cayuga Lake, while Dr. Smith records their appearance in 1797, 1814, '31 and 48.

BROOD XX.—*Septemdecim*—1866, 1883.

In the year 1883, and at intervals of 17 years thereafter, they will, in all probability, appear in western New York, western Pennsylvania and eastern Ohio. In the last mentioned State they occur more especially in Mahoning, Carroll, Trumbull, Columbiana and adjacent counties, overlapping, especially in Columbiana county, some of the

* Though they occurred in large numbers in Davidson county and other portions of Tennessee in 1855, and also the present year, yet in Lawrence county they appeared in 1856, instead of 1855—another instance of a belated brood.

territory occupied by Brood XV. In Pennsylvania, they occupy nearly all the western counties, and their appearance is recorded in 1832, '49 and '66, by Dr. Fitch (his second brood), Dr. Smith, and several of my correspondents; the following counties being enumerated: Armstrong, Clarion, Jefferson, Chemung, Huntingdon, Cambria, Indiana, Butler, Mercer and Beaver.

BROOD XXI.—*Septemdecim*—1867, 1884.

In the year 1884, and at intervals of 17 years thereafter, they will, in all probability, appear in certain parts of North Carolina and Central Virginia. In 1850 and 1867 they appeared near Wilkesboro N. C., and were also in Central Virginia during the last mentioned year, while Dr. Smith mentions them as occurring in Monroe county, and the adjacent territory, in Virginia in 1833 and 1850.

Dr. Harris (Inj. Insects, p. 210) records their appearance at Martha's Vineyard, Massachusetts, in 1833, but as I cannot learn that they were there, either in 1850 or 1867, I infer that Dr. Harris's informant was mistaken.

BROOD XXII.—*Septemdecim*—1868, 1885.

In the year 1885, and at intervals of 17 years thereafter, they will, in all probability, appear on Long Island; at Brooklyn, in Kings county, and at Rochester in Monroe county, New York; at Fall River, and in the southeastern portion of Massachusetts; at Oakland (Rutland?), Vermont; in Pennsylvania, Maryland, District of Columbia, Delaware and Virginia; in northwestern Ohio, in southeastern Michigan, in Indiana and Kentucky.

This brood has been well recorded in the East in 1715, 1732, 1749, 1766, 1783, 1800, 1817, 1834, 1851 and 1868. It is spoken of in "Hazzard's Register" for 1834, published in Philadelphia, while Mr. Rathvon has himself witnessed its occurrence during the four latter years in Lancaster county, Pa.

It is the fourth brood of Dr. Fitch, who only says that it "reaches from Pennsylvania and Maryland to South Carolina and Georgia, and what appears to be a detached branch of it occurs in the southeastern part of Massachusetts." He is evidently wrong as to its occurring in South Carolina and Georgia, and it is strange that he does not mention its appearance in New York, for Mr. F. W. Collins, of Rochester, in that State, has witnessed four returns of it there, namely: in 1817, '34, '51 and '68, while the Brooklyn papers record its appearance there the present season. As these two points in the State are about as far apart as they well can be, the intervening country is probably more or less occupied with this brood. Mr. H. Rutherford, of Oakland,* Vermont, records their appearance in that neighborhood in 1851 and 1868.

*I can find no such post office as Oakland in Vermont, and incline to believe that the *Tribune* compositor made Oakland out of Rutland, and more especially as Rutland is on the New York border.

(N. Y. Semi-Weekly *Tribune*, June 27). He also witnessed them in the same place in 1855, and as will be seen by referring to Brood XVIII, they also occurred on Long Island and in southeastern Massachusetts in that same year, 1855. Exactly 13 years intervening between 1855 and 1868, one might be led to suppose that they had a *tredecim* brood in the East. But did such a brood exist, it would certainly have been discovered ere this, in such old settled parts of the country, and all the records go to show that they have nothing but *septemdecim* there. By referring to Brood VIII, the mystery is readily solved, for we find that in that part of the country there are two *septemdecim* broods—the one having last appeared in 1855—the other the present year, 1868.

In Ohio, this brood occurred more or less throughout the whole western portion of the State, for our correspondents record them as having appeared in 1868 in Lucas and Hamilton and several intervening counties. Mr. F. C. Hill, of Yellow Springs, in Green county, Southwest Ohio, has witnessed their appearance in 1834, 1851 and 1868, and they occurred in the northwestern part of the State during the three same years; while the correspondent to the Department of Agriculture, from Toledo, Northwest Ohio (July, 1868, Monthly Rep.), says it is their 9th recorded visit there. Dr. Smith records it as occurring around Cincinnati, in Franklin, Columbiana, Pike and Miami counties.

In Indiana, there is reliable evidence of their appearance, in 1868, in the southern part of the State, in Tippecanoe, Delaware, Vigo, Switzerland, Hendricks, Marion, Dearborn, Wayne, Floyd, Jefferson and Richmond counties. The evidence seems to show that, as in Ohio, throughout the State, they belong to this *septemdecim* Brood XXII, for Mr. F. Guy, of Sulphur Springs, Mo., has personally informed me that they were in Southern Indiana in 1851, and even in Tippecanoe county, on the Wabash river, where, from their proximity to Brood XVIII, one might have inferred them to be *tredecim*, they are recorded as appearing in 1834 and '51.

In Kentucky they appeared around Louisville. In Pennsylvania, Maryland, Delaware and Virginia, the territory occupied by this brood is thus described by Dr. Smith: "Beginning at Germantown, Pa., to the middle of Delaware; west through the east shore of Maryland to the upper part of Ann Arundel county; thence through the District of Columbia to Loudon, West Virginia, where it ☞ laps over the South Virginia district (see Brood XII) from the Potomac to Loudon county, some 10 or 12 miles in width, and in this strip of territory Cicadas appear every 8th and 9th year. Thence the line extends through the north counties of Virginia and Maryland to the Savage mountains, and thence along the south tier of counties in Pennsylvania, to Germantown."

From the above synoptical view it results that there will, during the next 17 years, be broods of the Periodical Cicada somewhere or other in the United States in A. D. 1869, '70, '71, '72, '74, '75, '76, '77, '78, '79, '80, '81, '82, '83, '84 and '85—or every year but 1873. It further appears that the number of distinct broods, appearing in distinct years, within the following geographical districts, are as follows: In southern New England 4 broods, years '69, '72, '77 and '85; in New York 5 broods, years '72, '77, '82, '83 and '85; in New Jersey 2 broods, years '72 and '77; in Pennsylvania 7 broods, years '70, '71, '72, '77, '80, '83 and 85; in Ohio 7 broods, years '72, '78, '79, '80, 81, '83 and '85; in Indiana 4 broods, years '71, '76, '77 and '85; in Illinois 6 broods, years '71, '72*, '76, '77, '78 and '81*, and probably another in Jo Daviess county, year '70; in Wisconsin 2 broods, years '71 and '82; in Michigan 2 broods, years '71 and '85; in Iowa 2 broods, years '71 and '78; in Nebraska 1 brood, year '74; in Kansas 2 broods, years '72* and '79; in Missouri 4 broods, years '72*, 78, '79 and '81*; in Louisiana and Mississippi 3 broods, years '71*, '72* and 81*; in Tennessee 2 broods, years '72* and '81*; in Arkansas, Indian Territory and Alabama, 1 brood, year '81*; in Kentucky 3 broods, years '72, '81* and 85; in Georgia 4 broods, years '69*, '72*, '80* and '81*; in South Carolina 1 brood, year '81*; in North Carolina 6 broods, years '72?, '76, '77, '81?, '81* and '84; in East and West Virginia 5 broods, years '72, '77, '80, '81 and 84; in Maryland 4 broods, years '72, '76, 77 and 85; in District of Columbia 1 brood, year '85; in Delaware 2 broods, years '72 and 85; in Florida 1 brood, year 73*; in Texas 1 brood, year 75*.

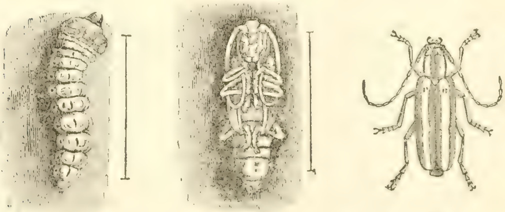
* The broods marked (*) belong to the 13-year or tredecim race of the Periodical Cicada.

APPLE-TREE BORERS.

(Coleoptera, Cerambicidæ.)

THE ROUND-HEADED APPLE-TREE BORER—*Saperda bivittata*, Say.

[Fig. 14.]



a *b* *c*

It is a fact which has not been disputed by any one whom I have queried on the subject, that apple trees on our ridges are shorter lived than those grown on our lower lands. Hitherto no particular reason has been given for this occurrence, but I think it is mainly attributable to the workings of the borer now under consideration. I have invariably found it more plentiful in trees growing on high land than in those growing on low land, and it has also been my experience that it is worse in ploughed orchards than in those which are seeded down to grass. Fifty years ago, large, thrifty, long-lived trees were exceedingly common, and were obtained with comparatively little effort on the part of our ancestors. They had not the vast army of insect enemies to contend with, which at the present day make successful fruit-growing a scientific pursuit. This Apple-tree borer was entirely unknown until Thomas Say described it in the year 1824; and, according to Dr. Fitch, it was not till the year following that its destructive character became known in the vicinity of Albany, N. Y., for the first time. Yet it is a native American insect, and has for ages inhabited our indigenous crabs, from which trees my friend, Mr. A. Bolter, took numerous specimens, in the vicinity of Chicago, ten years ago. It also attacks the quince, mountain ash, hawthorn, pear and the June-berry. Few persons are aware to what an alarming extent this insect is infesting the orchards in St. Louis, Jefferson and adjacent counties, and, for aught I know, throughout the State. A tree becomes unhealthy and eventually dwindles and dies, often without the owner having the least suspicion of the true cause—the gnawing worm within. Even in the orchard of the most worthy president of our State Horticultural Society, I found one or more large worms at the base of almost every tree that I examined, notwithstanding he had been of the opinion that there was not a borer of this kind on his place.

At Figure 14, this borer is represented in its three stages of larva (*a*), pupa (*b*), and perfect beetle (*c*). The beetle may be known by the popular name of the Two-striped Saperda, while its larva is best known by the name of the Round-headed apple-tree borer, in contradistinction to the Flat-headed species, which will be presently treated of.

The average length of the larva, when full-grown, is about one inch, and the width of the first segment is not quite $\frac{1}{4}$ of an inch. Its color is light yellow, with a tawny yellow spot of a more horny consistency on the first segment, which, under a lens, is found to be formed of a mass of light brown spots. The head is chestnut-brown, polished and horny, and the jaws are deep black. The pupa is of rather lighter color than the larva, and has transverse rows of minute teeth on the back, and a few at the extremity of the body; and the perfect beetle has two longitudinal white stripes between three of a light cinnamon-brown color. The Two-striped Saperda makes its appearance in the beetle state during the months of May and June, and is seldom seen by any but the entomologist who makes a point of hunting for it—from the fact that it remains quietly hidden by day and flies and moves only by night. The female deposits her eggs during the month of June, mostly at the foot of the tree, and the young worms hatch and commence boring into the bark within a fortnight afterwards. These young worms differ in no essential from the full grown specimens, except in their very minute size; and they invariably live, for the first year of their lives, on the sap-wood and inner bark, excavating shallow, flat cavities which are found stuffed full of their sawdust-like castings. The hole by which the newly hatched worm penetrated is so very minute that it frequently fills up, though not till a few grains of castings have fallen from it; but the presence of the worms may be generally detected, especially in young trees, from the bark, under which they lie, becoming darkened, and sufficiently dry and dead to contract and form cracks. Through these cracks, some of the castings of the worm generally protrude, and fall to the ground in a little heap, and this occurs more especially in the spring of the year, when, with the rising sap and frequent rains, such castings become swollen and augment in bulk. Some authors have supposed that the worm makes these holes to push out its own excrement, and that it is forced to do this to make room for itself; but, though it may sometimes gnaw a hole for this purpose, such an instance has never come to my knowledge, and that it is necessary to the life of the worm is simply a delusion, for there are hundreds of boring insects which never have recourse to such a procedure, and this one is frequently found below the ground, where it cannot possibly thus get rid of its castings. It is currently supposed that this borer penetrates into the heart wood of the tree after the first year of its existence, whereas the Flat-headed species is supposed to remain for the most part immediately under the bark; but I find that on these points no rules can be given, for the Flat-headed species also frequently penetrates into the solid heart wood, while the species under consideration is frequently found in a full grown state just under the inner bark, or in the sap-wood. The usual course of its life, however, runs as follows:

As winter approaches, the young borer descends as near the ground as its burrow will allow, and doubtless remain inactive till the following spring. On approach of the second winter it is about one-half grown and still living on the sap-wood; and it is at this time that these borers do the most damage, for where there are 4 or 5 in a single tree, they almost completely girdle it. In the course of the next summer when it has become about three-fourths grown, it generally commences to cut a cylindrical passage upward into the solid wood, and before having finished its larval growth, it invariably extends this passage right to the bark, sometimes cutting entirely through a tree to the opposite side from which it commenced; sometime turning back at different angles. It then stuffs the upper end of the passage with sawdust-like powder, and the lower part with curly fibres of wood, after which it rests from its labors. It thus finishes its gnawing work during the commencement of the 3d winter, but remains motionless in the larval state till the following spring when it casts off its skin once more and becomes a pupa. After resting three weeks in the pupa state it becomes a beetle, with all it members and parts at first soft and weak. These gradually harden and in a fortnight more it cuts its way through its sawdust-like castings, and issues from the tree through a perfectly smooth and round hole. Thus it is in the tree a few days less than three years, and not merely two years as Dr. Fitch suggests. I have come to this conclusion from having frequently found, during the past summer, worms of three distinct sizes in the same orchard, and Mr. D. B. Wier of Lacon, Ills., had previously published the fact*, while a correspondent to the *Country Gentleman* of Albany, N. Y.† who says he has large experience with this borer, sent to the editors specimens of all three sizes, which he calls "this years, two and three year old worms." The individual from which I drew my figures, and which was taken from a crab apple tree, went into the pupa state on the 14th day of March and became a beetle on the 15th of April; but was doubtless forced into rapid development by being kept throughout the winter in a warm room.

Remedies.—From this brief sketch of our Round-headed borer, it becomes apparent that plugging the hole to keep him in, is on a par with locking the stable door to keep the horse in, after he is stolen; even supposing there were any philosophy in the plugging system, which there is not. The round smooth holes are an infalliable indication that the borer has left, while the plugging up of any other holes or cracks where the castings are seen, will not affect the intruder. This insect probably has some natural enemies belonging to its own great class, and some of our wood-peckers doubtless seek it out from its retreat and devour it; but its enemics are certainly not sufficiently under our control, and to grow healthy apple trees, we have to fight it artificially. Here again prevention will be found better than cure, and a stitch in time will not only save nine, but fully ninety-nine.

Experiments have amply proved that alkaline washes are repulsive to this insect, and the female beetle will not lay her eggs on trees protected by such washes. Keep the base of every tree in the orchard free from weeds and trash, and apply soap to them during the month of May, and they will not likely be troubled with borers. For this purpose soft soap or common bar soap can be used. The last is perhaps the most convenient and the newer and softer it is, the better. This borer confines himself almost entirely to the butt of the tree, though very rarely it is found in the crotch. It is therefore only necessary in soaping, to rub over the lower part of the trunk and the crotch, but it is a very good plan to lay a chunk of the soap in the principal crotch, so that it may be washed down by the rains. In case these precautions have been unheeded, and the borer is already at work, many of them may be killed by cutting through the bark at the upper end of their burrows, and gradually pouring hot water into the cuts so that it will soak through the castings and penetrate to the in-

Prairie Farmer, Chicago, April 20, 1867.

†*Country Gentleman*, Sept. 12, 1867.

sect. But even where the soap preventive is used in the month of May, it is always advisable to examine the trees in the fall, at which time the young worms that hatched through the summer may be generally detected and easily cut out without injury to the tree. Particular attention should also be paid to any tree that has been injured or sun-scalded, as such trees are most liable to be attacked. Mr. Wier who has had considerable experience with this insect, thus describes his method of doing this work, in the article already alluded to:

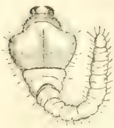
"I will suppose that I have a young orchard of any number of trees, say a thousand, the second season after planting, about the last of July, or during the first half of August, with a common hoe, I take all the weeds and other trash, and about an inch of soil, from the crown of the trees; then, any time from the first to the middle of September, with a pocket-knife, examine carefully the stem of each tree; the borer can readily be found by the refuse thrown out of the hole made on entering; this refuse of a borer, of the same season's growth, will be about the size of a pea, and, being of a glutinous nature, sticks around the mouth of the hole, and can rapidly be seen; older ones throw out coarser chips that fall to the ground. [As already shown these chips are not thrown out by the borer, but are forced out by swelling.] When one is found, take the knife and cut him out. If an orchard is carefully examined in this way each year, there need be but few, if any borers missed, and as they are more easily found the second fall of their growth, and can have done but little damage at that time, we would never receive any serious injury from them. Now, it is no great task to do this; a man will clear the litter and soil from around a thousand trees, in a day, and can take the borers out in another day. I will agree to do both jobs carefully in one day's time. A great undertaking is it not?"

He also has observed that some varieties of the apple-tree have a greater immunity from the attacks of this borer, than have others; on account of the young larva, when it is first hatched, being drowned out by the sap, but he does not mention any particular varieties other than those that are the "more vigorous and late growing."

THE FLAT-HEADED APPLE-TREE BORER—*Chrysobothr femorata*, Fabr.

(Coleoptera, Buprestidæ.)

[Fig. 15.]



[Fig. 16.]

This borer which is represented in the larva state at Figure 15, may at once be recognized by its anterior end being enormously enlarged and flattened. It is paler than the preceding, and makes an entirely different burrow. In consequence of its immensely broad and flattened head, it bores a hole of an oval shape and twice as wide as high. It never acquires much more than half the size of the other species, and is almost always found with its tail curled completely round towards the head. It lives but one year in the tree and produces the beetle, represented at Figure 16, which is of a greenish black color with brassy lines and spots above, the underside appearing like burnished copper. This beetle flies by day instead of by night, and may often be found on different trees basking in the sunshine. It attacks not only the apple, but the soft maple, oak, peach, and is said to attack a variety of other forest trees; though, since the larvæ of the family (BUPRESTIDÆ) to which it belongs all bear a striking resemblance to each other, it is possible that this particular species has been accused of more than it deserves.

It is, however, but far too common in the Valley of the Mississippi, and along the Iron Mountain and Pacific railroads, it is even more common than the preceding species. Mr. G. Pauls, of Eureka. informs me that it has killed fifty apple trees for him, and Mr. Votaw, and many others in that neighborhood have suffered from it in like manner. It is also seriously affecting our soft maples by riddling them through and through, though it confines itself far the most part to the inner bark, causing peculiar black scars and holes in the trunk. Unless its destructive work is soon checked, it bids fair to impair the value of this tree for shade and ornamental parposes, as effectually as the Locust borers have done with the locust trees.

REMEDIES.—Dr. Fitch found that this borer was attacked by the larvæ of some parasitic fly, belonging probably to the *Chalcis* family, but it is greatly to be feared that this parasite is as yet unknown in the west. At all events this flat-headed fellow is far more common with us than with our eastern brethren. As this beetle makes its appearance during the months of May and June, and as the eggs are deposited on the trunk of the tree, as with the preceding species, the same method of cutting them out or scalding them can be applied in the one case as in the other; while the soap preventive is found to be equally effectual with this species as with the other. It must, however, be applied more generally over the tree, as they attack all parts of the trunk, and even the larger limbs.

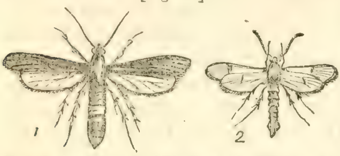
THE PEACH BORER—*Ægeria exitiosa*, Say.

(Lepidoptera, Ægeridæ.)

This pernicious borer I find to be quite common throughout the State. It is withal an insect so familiar to the peach-grower, and its history has been so often given in current entomological works that I should let it go unnoticed, were it not for the numerous letters of inquiry about it that have been sent to me during the year. For a complete and lengthened history of it, I refer the reader to the first of Dr. Fitch's most excellent reports.

From the Round-headed Apple-tree borer, to which it bears some resemblance both in its mode of work and general appearance, it is at once distinguished by having six scaly and ten fleshy legs. It works also more generally under the surface of the ground, and goes through its transformations within a year, though worms of two or three sizes may be found at almost any season. When full grown the worm spins for itself a follicle of silk, mixed with gum and excrement, and in due time issues as a moth. As it is not so well known in this last state, I annex (Fig. 17) figures of both male (2) and female (1) moths. As will be seen from these figures, the two sexes differ very materially from each other, the general color in both being glossy steel-blue. Some specimens which were received from Mr. W. S. Jewett, of Pevely, Jefferson county, commenced issuing as moths on the 20th of July, but I found empty follicles the latter part of May in trees which had been thoroughly wormed the year before, and from which the moths has consequently left at that early date. This borer likewise attacks the plum-tree, though singularly enough it causes no exudation of gum in this as it does in the peach tree.

[Fig. 17.]



REMEDIES.—I have had ample occasion to witness the effects of the mounding system during the summer, in several different orchards, and am fully convinced that it is the best practical method of preventing the attacks of this insect, and that it matters little whether ashes or simple earth be used for the mound. True, there are parties who claim (and among them Dr. Hull, of Alton, Ills.,) that the almost complete exemption from borers in mounded peach-orchards is due, not to any special effect produced by the mound, but to the general rarity of the insect. But I have found no general rarity of the insect, wherever I have been in our own State; but on the contrary, have with difficulty found a single tree in any orchard that was in anywise neglected, that did not contain borers; while I have found mounded trees entirely exempt. The following paragraph communicated to the *Western Rural* by Mr. B. Pullen, of Centralia, Illinois, touches on this point, and I can bear witness to the thrift and vigor of Mr. P.'s trees:

"As spring will soon be upon us I wish to add my testimony in favor of the "banking system," as a preventive against the attacks of the peach-borer. As to its efficacy there can be no doubt. I have practiced it four years with complete success. I would not advise its adoption until after the trees are four years old. During most of this period the bark is tender, and trees are liable to be entirely girdled by even a single worm. Safety lies only in personal examination and removal with the knife, in fall and spring (September and April). In April of the fourth year bank up to the hight of from ten to twelve inches, pressing the dirt firmly around the tree. A little dirt should be added each successive spring. It is not only a preventive but a great saving of labor."

As further testimony, and with a view to giving the method by which the trees may be mounded, I also insert the following communication from E. A. Thompson, of Hillside (near Cincinnati), Ohio, which appeared in the *Journal of Agriculture*, of Nov. 14, 1868:

"The mounding system was first practiced, so far as I know, by Isaac Bolmar, of Warren county, Ohio. I visited his orchards some years ago—acquainted myself with his system—and concluded to try it upon my orchard of 4,000 trees—then one year planted. I plant my trees in the fall, and in the spring following cut them back to six inches above the bud. The tree then instead of having one body has several—from three to six. The second summer I plow both ways, turning the furrows toward the trees. The men follow with shovels, throwing the loose soil around the tree to the heighth of about one foot. In the fall I cut the trees back, taking off about one-third of the year's growth. The next spring or summer I pursue the same method, raising the mound about one foot higher; cut back in the fall, and the third summer repeat the process, raising the mound another foot, which finishes the job. The mound will then be about three feet high at its apex and six feet in diameter at its base. The mounding need not be done in the summer, or at any particular season; it is just as well done in the fall when the hurry is over. The dirt is never taken away from the trees—in fact it cannot be removed without injury to the tree—for the young rootlets each year keep climbing up through this mound. I had occasion to remove one of these mounds a few days since and found it a mass of healthy roots.

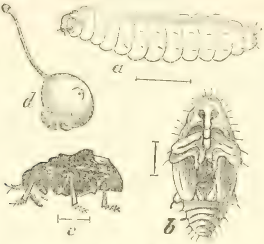
Now for the benefits. First you have no trouble with grub or borer: he must have light and air, and the mound is too much for him; he comes out and that is the last of him. I have never wormed my trees, or hunted for the borer, and an orchard of healthier or thriftier trees cannot be found. It has been asserted that the borer will re-appear again near the top of the mound—but I am satisfied this is not the case; I have never thus far been able to find one. Second, the system imparts longevity to the tree. I saw a tree in Warren county treated in this manner *thirty* (30) years old, still healthy and bearing annual crops. Third, trees thus treated are not subject to disease. I have never had a case of *yellows* in my orchard. Fourth, the expense is trifling—one man can mound fifty trees per day. The system can be applied to old as well as young orchards; but if old trees are thus treated they should be first severely cut back, when they will make a growth of young wood."

The application of soap does not appear to prevent the moth from depositing her eggs, as in the case of apple tree borers. Hot water is very efficient in killing the young borers, after the earth has been removed, and it should be applied copiously, and *hot* nigh unto the boiling point, for there is no danger of its injuring the tree. Those who grow tobacco will also find it profitable to throw the stems around the butts of their trees, as there is good evidence of its being obnoxious to the moth.

THE PLUM CURCULIO—*Conotrachelus nenuphar*, Herbst.

(Coleoptera, Curculionidæ).

[Fig. 18.]



I regret to have to state that Missouri is none the less exempt from the ruinous work of this persistent "Little Turk," than are her sister States, though I have not heard of a single instance where they have been so numerous as they were last summer in Southern Illinois; for Parker Earle, of South Pass, captured 6,500 from 100 peach trees, during the first six days of May. In every locality which I have visited, this beetle is considered *the* enemy to stone fruit, and though so much has been written about it, I find it necessary to devote a few pages to its consideration, since some of the points in its natural history are not entirely and satisfactorily settled, even yet. There is in fact conflicting evidence from different authors, as to whether it is single or double brooded each year, and as to whether it hybernates principally in the perfect beetle state, above ground, or in the preparatory states, below ground; the very earliest accounts that we have of the Plum Curculio, in this country, differing on these points. Thus, it was believed by Dr. James Tilton, of Wilmington, Deleware, who wrote at the very beginning of the present century, and by Dr. Joel Burnett, of Southborough, and M. H. Simpson, of Saxonville, Massachusetts, who both wrote interesting articles on the subject, about fifty years afterwards; that it passed the winter in the larval or grub state, under ground, and Harris seems to have held the same opinion. But Dr. E. Sanborn, of Andover, Massachusetts, in some interesting articles published in 1849 and 1850, gave as his conviction that it hybernates in the beetle state above ground. Dr. Fitch, of New York, came to the conclusion that it is two-brooded, the second brood wintering in the larva state in the twigs of pear trees: while Dr. Trimble, of New Jersey, who devoted the greater part of a large and expensive work to its consideration, decided that it is single-brooded, and that it hybernates in the beetle form above ground. Since the writings of Harris and Fitch, and since the publication of Dr. Trimble's work there have been other papers published on the subject. The first of these was a tolerably exhaustive article, by Mr. Walsh, which appeared in the *Practical Entomologist* (Vol. II, No. 7), in which he takes the grounds that the Curculio is single-brooded; though subsequently he came to the very different conclusion that it was double-brooded, (First Annual Rep., p. 67). In the summer of 1867 I spent between two and three weeks in Southern Illinois, during the height of the Curculio season, and closely watched its manœuverings. From the fact that there was a short period about the middle of July, when scarcely any could be caught from the trees, and that after a warm shower they were quite numerous, having evidently just come out of the ground,* I concluded that it was double-brooded and communicated to the *Prairie Farmer* of July 27th, 1867, the passage to that effect, under the signature of "V," which is quoted by Mr. Walsh (Rep., p. 67), as corroborative of its two-brooded character. Subsequent calculation induced me to change my mind, and I afterwards gave it as my opinion that there was but one main brood during the year, and that where a second generation was produced it was the exception, (Trans. Ills. State Hort. Soc., 1867, p. 113). Finally Dr. E. S. Hull, of Alton, Illinois, who has had vast personal experience with this insect, read a most valuable essay on the subject, before the meeting of the Alton (Ills.), Horticultural Society of March, 1868, in which he evidently concludes they are single-brooded, and that they pass the winter, for the most part, in the preparatory states, underground.

Now, why is it that persons who, it must be admitted, were all capable of correct observation, have differed so much on these most interesting points in the economy of our Plum Curculio? Is there any explanation of these contradictory statements? I think there is, and that the great difficulty in the study of this as well as of many other insects, lies in the fact that we are all too apt to generalize. We are too apt to draw distinct lines, and to create rules which never existed in nature—to suppose that if a few insects which we chance to watch are not single-brooded, therefore the species must of necessity be double-brooded. We forget that Curculios are not all hatched in one day, and from analogy, are very apt to underrate the duration of the life of the Curculio in the perfect beetle state. Besides, what was the exception one year may become the rule the year following. In breeding butterflies and moths, individuals hatched from one and the same batch of eggs on the same day, will frequently, some of them, perfect themselves and issue in the fall, while others will pass the winter in the imperfect state, and not issue till spring; and in the case

*I have often noticed, and the fact has been remarked by others, that insects which have been comparatively inactive for many days, in dry weather, fly freely after a warm shower, and it is possible that the increase of the Curculio after such rains is partly due to their flying in more vigorously from the surrounding woods.

of a green worm that is found on raspberry leaves, and which passes the winter under-ground, and develops into a four-winged fly (*Selandria rubi* of my manuscript) in the spring; I have known a difference of three months to occur between the issuing of the first and last individuals of the same brood, all the larvæ of which had entered the ground within three days. It is also a well recorded fact, both in this country and in Europe, that in 1868, owing, probably, to the unusual heat and drouth of the summer, very many insects which are well known to usually pass the winter in the imperfect state, perfected themselves in the fall, and in some instances produced a second brood of larvæ. Far be it from me to pronounce that there is no such thing as rule in nature, and that we cannot, therefore, generalize; I simply assert that we frequently draw our lines too rigidly, and endeavor to make the facts come within them, instead of loosening and allowing them to encompass the facts. It was thus that the Joint-worm fly was for so long a time suspected to be a parasite instead of the true culprit, because all the other species in the genus (*Eurytoma?*), to which it was supposed to belong, were known to be parasitic. For those who are not acquainted with the appearance of the Plum Curculio, in its different stages, I have prepared, at Figure 18, correct and magnified portraits of the full-grown *larva* (*a*); of the *pupa* (*b*) into which the larva is transformed within a little cavity underground, and of the perfect curculio (*c*).

With this prelude I will now give what I believe to be facts in its natural history, founded on my own observations of the past year, and on the observations of others. I firmly believe:

1—That Plum Curculios are a most unmitigated nuisance, and, though most beautiful objects under the microscope, the fruit-growers of the United States, if they had their own way about the matter, would wish them swept from off the face of the Earth, at the risk even of interfering with the "Harmony of Nature."

2—That they are more numerous in timbered regions than on the prairie.

3—That they *can* fly and *do* fly during the heat of the day, and that cotton bandages around the trunk, and all like contrivances to prevent their ascending the trees, are worse than useless, and a result only of ignorance of their economy.

4—That by its punctures it causes the dreaded peach-rot to spread, whenever that disease is prevalent, though it cannot possibly be the first cause of the disease. The peach-rot is now pretty generally acknowledged to be a contagious disease of a fungoid nature, and I believe that the spores of this fungus, "a million of which might be put upon the point of a stick whittled down to nothing," attach themselves more readily to fruit which has the skin abraded, and from which the gum issues, than to whole or unpunctured fruit. With this belief I made some effort to procure, for the benefit of my readers, a synopsis of the growth of this fungus; but, alas! I find that nothing but confusion exists with regard to it. Upon applying to my friend, Dr. T. C. Hilgard, of St. Louis—a recognized authority on such subjects—he furnished me with the article which may be found in the *Journal of Agriculture* of January 16th, 1869. I most respectfully declined publishing it in these pages, knowing that the reader would not be likely to understand what was either too *profound* or too befogged for my own comprehension, and those who require a *synopsis* of this fungus, are referred to that article. Verily, we must conclude that Peach-rot is not yet much understood, if a more clear exposition of it cannot be given!

5—That they prefer smooth-skinned to rough skinned fruit.

6—That up to the present time the Miner and other varieties of the Chickasaw plum have been almost entirely exempt from their attacks, and that in the Columbia plum the young larvæ are usually "drowned out" before maturing.

7—That they deposit and mature alike in nectarines, plums, apricots, cherries and peaches; in black knot on plum trees, and in some kinds of apples, pears and quinces; and, according to Dr. Hull, they also deposit but do not mature in strawberries, gooseberries, grapes, and in the vigorous shoots of the peach tree.

8—That it is their normal habit to transform underground, though some few undergo their transformations in the fruit.

9—That the cherry, when infested, remains on the tree, with the exception of the English Morello, which matures and then separates from the stem; but that all other fruits, when containing larvæ, usually fall to the ground. In the larger fruits four or five larvæ may sometimes be found in a single specimen, and I have taken five full grown larvæ from a peach that had evidently fallen and laid on the ground for over a week.

10—That the greater portion of them pass the winter in the perfect beetle state, under the old bark of both forest and fruit trees, under shingles, logs, and in rubbish of all kinds, and especially in the underbrush of the woods.

11—That they are always most numerous in the early part of the season on the outside of those orchards that are surrounded with timber, and that they frequently shelter in apple-trees and other trees before the stone fruit forms.

12—That a certain portion of them also pass the winter underground, both in the larva and pupa states, at a depth, frequently of from 2 to 3 feet.

13—That those which hybernate as beetles, begin to leave their winter quarters and to enter our orchards, throughout central Missouri, during the first days of May, and commence to puncture the fruit about the middle of the same month—a little earlier or later according to the season—the fruit of the peach being at the time about the size of a small marble.

14—That those which hybernate underground continue to develop and to issue from the earth during the whole month of May.

15—That both males and females puncture the fruit for food, by gouging hemispherical holes, but that the female alone makes the well-known crescent-shaped mark (see Fig. 18, *d.*), as a nidus for her egg.

16—That the egg is deposited in the following manner, the whole process requiring about five minutes: Having taken a strong hold on the fruit (see Fig. 18, *d*), the female makes a minute cut with the jaws, which are at the end of her snout, just through the skin of the fruit, and then runs the snout under the skin to the depth of 1-16th of an inch, and moves it back and forth until the cavity is large enough to receive the egg it is to retain. She next changes her position, and drops an egg into the mouth of the cut; then, veering round again, she pushes it by means of her snout to the end of the passage, and afterwards cuts the crescent in front of the hole so as to undermine the egg and leave it in a sort of flap; her object apparently being to deaden this flap so as to prevent the growing fruit from crushing the egg, though Dr. Hull informs me that he has repeatedly removed the insect as soon as the egg was deposited and before the flap was made, and the egg hatched and the young penetrated the fruit in every instance.

17—That the egg is oval, of a pearl-white color, large enough to be seen with the naked eye, requires a temperature of at least 70° Fahr. to hatch it, and may be crushed with the finger-nail without injuring the fruit.

18—That the stock of eggs of the female consists of from 50 to 100; that she deposits from 5 to 10 a day, her activity varying with the temperature.

19—That the last of those curculios which hybernated in the imperfect state under-ground have not finished depositing till the end of June and beginning of July, or about the time that the new brood developed from the first laid eggs of the season, are beginning to issue from the ground; and that we thus have them in the month of June in every conceivable state of existence, from the egg to the perfect insect.

20—That the period of egg depositing thus extends over more than two months.

21—That all eggs deposited before the first of July generally develop and produce Curculios the same season, which issue from the ground during July, August and September and hybernate in the perfect state.

22—That most of those which hatch after the first of July, either fail to hatch, or the young larvæ die soon after hatching, owing perhaps to the more ripe and juicy state of the fruit, being less congenial to them; and that what few do mature, which hatch after this date, undergo their transformations more slowly than the rest and pass the winter in the ground.

23—That the perfect Curculio while in the ground is soft and of a uniform red color, and that it remains in this state an indefinite period, dependent on the weather, usually preferring to issue after a warm rain.

24—That in a stiff clay soil a severe drought will kill many of them while in this last named condition, and that larvæ contained in stone fruits that fall upon naked ploughed ground where the sun can strike them, generally die.

This catalogue might be lengthened, but already embraces all the more important facts, and I think they sufficiently prove that the Curculio is single-brooded. There is, it is true, no particular reason why the earliest developed Curculios, or those which issue from the ground during the fore part of July, should not pair and deposit eggs again; other than it does not appear to be their nature to do so. Such an occurrence is by no means an isolated one in insect life, and aside from the fact that late fruit is almost entirely exempt from them, we have the experiments of Dr. Trimble which indicate that they have to pass through the winter before being able to reproduce their kind. The only other experiments that were ever made to prove the contrary hypothesis, are those detailed by Mr. Walsh, in his First Annual Report (p. 68), and, as may be seen from their perusal they prove nothing at all. To give them in his own words, I here quote them in full:

"EXPERIMENT 1ST.—On June 24th, I placed in a large glass vase, with moist sand at the bottom of it, a quantity of wild plums, every one of which I had previously ascertained to bear the crescent symbol of the 'little Turk.' During the three following weeks I added from day to day a number of plums, all of them bearing the same symbol, that had fallen from a tame plum-tree in my garden. The whole number of plums, as I subsequently ascertained, was 183, and the tame fruit probably formed about a fourth part of the whole. The first Curculio came out July 19th, and with the exception of July 21st and August 1st, there were more or less came out every day till August 4th, inclusive; after which day no more came out. The numbers coming out on each successive day were as follows, the very large number on July 25th having been probably caused by my wetting the sand on that morning rather copiously: 1, 18, 0, 3, 4, 2, 55, 8, 4, 3, 1, 2, 1, 0, 5, 4, 2. Total, 113. On examining the contents of the vase, November 29th, I found five dead and dried up Curculios among the plums, and among the sand sixteen dead and immature specimens, which had obviously failed to make their way up to the light of day, besides the remains of a good many individuals which had perished in the sand in the larva or pupa state, and were not counted. The Grand Total from 183 infested plums was, therefore, 134 Curculios in the beetle state, and an unknown number of larvæ and pupæ."

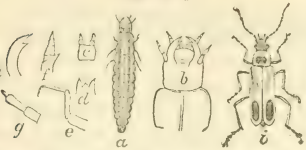
"EXPERIMENT 2d.—On July 27th, or eight days before the Curculios in the preceding experiment had ceased coming out, I placed in a vase, similar to the above, 243 plums, gathered promiscuously off some badly-infested wild plum-trees. From this lot no Curculios whatever came out till August 23d, and from that day, until September 14th, more or less came out daily, with the exception of five out of the 23 days, the numbers on the respective days being as follows: 3, 1, 2, 2, 2, 3, 2, 2, 5, 3, 1, 0, 5, 6, 3, 2, 0, 0, 0, 1, 0, 1, 1. Subsequently, on September 18th, there came out 3, on September 24th, 1, and on September 28th, 1; after which no more made their appearance. Total, 50 Curculios from 243 plums, some stung and some not. On examining the contents of this vase on November 29th, I found a single dead Curculio among the plums, making a Grand Total of 51 Curculios bred from these plums. There were no specimens, either in larva, pupa or beetle state, to be found among the sand in the vase on November 29th; which was, perhaps, due to the contents having kept much moister than those of the first vase, though on July 25th I had, as I thought, moistened the sand in the first vase quite sufficiently."

Now because there was an intermission of 19 days when no Curculios came out, Mr. Walsh arrives at once to the conclusion that there are two distinct broods, the second of which is, "of course" generated by the first. If the infected plums had been collected and placed in vases day by day, or if the curculios bred in the first experiment had been furnished with fresh plums and had actually paired and deposited again, the experiments would have been satisfactory; but as they stand, they seem to me, on the very face, to forbid the conclusions to which the experimenter arrived. In both these experiments the very result was obtained that might have been expected, for I have myself proved, that with favorable conditions the Curculio remains under ground about 3 weeks, and as there would naturally be none advanced beyond the full grown larva state, when first put into the vase, perfect Curculios could not possibly appear till they had had time to transform, or in other words, till about three weeks after the plums were placed in the vase. Thus from the plums placed in the vase on the 24th of June the first Curculios appeared on the 19th of July—25 days afterwards; while from those placed in the second vase on July 27th, the first Curculios appeared on the 23d of August—27 days afterwards. The interval also, of 19 days which elapsed between the issuing of the last Curculios in the first experiment and the first curculios in the last experiment, was exactly what should have been expected, since the plums were placed in the second vase eight days before the last curculios in the first vase had issued. Had the plums been placed in the second vase 10 days earlier or 10 days later, there would have been an intermission of 9 or 29 days accordingly, in their coming out, etc., etc. Moreover, a period of at least 50 days elapses between the deposition of an egg and the time required for that egg to develop into a Curculio and even on the supposition that the female commenced depositing the moment she left the ground, which is certainly not the case, the Curculios bred in the second vase could not possibly have been the progeny of any that appeared contemporaneously with those bred from the first vase.

NATURAL REMEDIES.—There is no very good evidence that any true parasites infest the Curculio, and though it was well known that ants attacked and killed the larvæ as they left the fruit to enter the ground, yet until the present year no other cannibals were known to attack it; but Mr. Walsh in his interesting account of a trip through Southern Illinois has shown that there are several cannibal insects which habitually prey upon it. From this account which was published in the AMERICAN ENTOMOLOGIST—pp. 33-35—I condense the following facts.

THE PENNSYLVANIA SOLDIER BEETLE (*Chauliognathus pennsylvanicus*, DeGeer).—This beetle which is represented at Figure 19, *i* is of a yellow color, marked with black. It is a common species and I have found it quite abundant in our own State on the flowers of the Golden-rod during the months of September and October. Its larva (Fig. 7, *a*) is one of the most effectual destroyers of the Curculio while the latter is above ground in the larva state. It attacks the Curculio grub within the fruit while it yet hangs on the tree, and also enters the fruit which falls to the ground, for the same purpose. In the summer of 1867 I found this same larva on an apple tree of the Early Harvest variety, the fruit of which contained Curculio larvæ from which I subsequently bred perfect Curculios. It is quite active in its movements, and the general color is smoky brown, with a velvety appearance, and for the benefit of those interested I subjoin the technical desription of it:

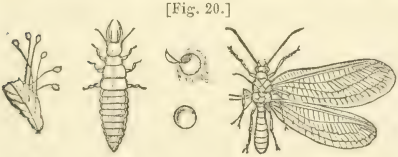
[Fig. 19*.]



CHAULIOGNATHUS PENNSYLVANICUS, DeGeer—*Larva*—Head shining rufous, with two black patches behind, transversely arranged; labrum retractile, dark colored, horny and deeply emarginate with a central tooth; maxillary palpi 4-jointed; labial palpi 2-jointed; antenna 3-jointed, the last joint very small; body rather flattened, of an opaque velvety-brown color above, with a somewhat darker subdorsal line, which is widened on the three thoracic segments; a very distinct lateral spiracle to every segment of the body except the anal one, making altogether eleven pairs of spiracles, all of them exactly alike, and in range with each other. Body beneath suddenly very pale brown, the dividing line between the darker and the paler shades of brown upon each segment being a semicircular curve, with its concavity upward; legs six; a moderate anal proleg; length 0.65 inch.

LACEWING LARVA.—The larvæ of our lacewing flies (*Chrysopa*) seem to have the same habit of attacking Curculio grubs above ground, and great numbers of them were found in the act last summer by Mr. E. Leming, of Cobden, Illinois. The particular species which those belonged to that were occupied in this good manner, has not yet been ascertained, but as they are all known to be cannibals it is possible that more than one species have this praiseworthy habit, though their general food consists of plant-lice. The lacewing flies are common all over the country, and may at once be recognized by their delicate green bodies, lace-like wings and by their brilliant golden eyes; but more especially by a peculiarly disagreeable odor which they are capable of emitting when handled. Our American lacewings, like those of Europe, are capable of emitting this odor, and those who have once experienced it require no description to recall it. One of these

[Fig. 20.]



a b c d

*Explanation of Figure 19—*h* the left upper jaw (*mandible*), *f* the left lower jaw (*maxil*), *c* the under lip (*labium*), *d* the upper lip (*labrum*), *g* the antenna, *c* one of the legs, *a* the larva natural size, *b* head and first segment of same enlarged.

flies, with the left wings cut off to save space, is represented at Figure 20 *d*, and a typical larva is represented in outline in the same figure at *b*. The female deposits her eggs upon different plants, attaching them at the extremity of a long and very slender foot-stalk (see Fig. 20, *a*). This filament is composed of a viscid matter which she discharges and which quickly hardens on exposure to the atmosphere. We see here, as everywhere else in Nature, an Allwise creative forethought, and a wonderful adaptation to a particular end, in the instinct which prompts, and the power which enables the female lacewing to thus deposit her eggs; for the newly hatched larvæ are so exceedingly voracious that the first hatched would devour the eggs which yet remained unhatched, if they could but reach them.

The larvæ when full-grown spin perfectly round white cocoons (Fig. 20, *c*), by means of a spinneret with which they are furnished at the extremity of the body, and they attach them with threads of loose silk to the underside of fences and in other sheltered situations. These cocoons are of an extraordinary small size compared with the larva which spins them, or with the perfect insect which escapes from them, as may be readily seen by referring to the above figures which bear the relative proportions. After completing the cocoon, I think the larva partly cuts a circle at one side severing the fibers sufficiently to enable their ready separation; for in issuing, the pupa pushes open a small lid, which is cut perfectly smooth, and just spirally enough to allow it to hang at one end as on a hinge. I have also noticed another fact, which, so far as I am aware, has not been recorded by any previous writer, which is, that the insect issues from this cocoon in an active sub-imago state, from which after a few hours the winged fly emerges, leaving behind it a fine silvery-white transparent skin.

THE SUBANGULAR GROUND BEETLE—(*Aspidiglossa subangulata*, Chaud.)—This small polished black beetle which is represented enlarged at Figure 21, the hair line at the side showing the natural size, also, in all probability serves us a good turn in helping to diminish the numbers of the Curculio, for Mr. Walsh found him in a peach that had contained Curculio grubs, and as the great family of beetles (*Carabus*) to which he belongs are all cannibals so far as is known, and as he was therefore evidently not inside the peach for the fruit itself, he is to be strongly suspected of being a Curculio hunter. To adopt Shakespeare's mode of reasoning:

[Fig. 21.]

> "Who finds the heifer dead, and bleeding fresh,
> And sees fast by a butcher with an axe,
> But will suspect 'twas he that made the slaughter?"

The Curculio is not even safe from the attacks of cannibals when underground, for the larva which is represented of the natural size at Figure 22, *A*, seeks it in its hiding place and mercilessly devours it. This larva is of a shining brown-black color above, and dull whitish beneath, and I subjoin herewith the technical description:

[Fig. 22.*]

Shining brown-black and horny above; thorax immaculate above; sutures and sides of the abdominal dorsum, and all beneath, except the head, pale dull greenish white; a narrow, horny, elongate, abbreviated lateral dark stripe on the dorsum of each of the abdominal joints (4—12); joints 4—10 beneath, each with seven pale-brown horny spots, namely, a large subquadrate spot followed by two small dots in the middle, an elongate spot on each side, and between that and the two medial small dots a second elongate spot, only half the length and breadth of the lateral one (Fig. 22, *j*); joint 11 beneath has only the medial subquadrate spot and the lateral elongate one (Fig. 22, *i*); and joint 12 beneath has nothing but the subquadrate spot (Fig. 22, *h*); legs six, of a pale rufous color; the usual elongate carabidous proleg on joint 12, and on each side of its tip an elongate exarticulate cercus, garnished with a few hairs; antennæ four-jointed; labial palpi two-jointed; maxillary palpi four-jointed. Length 1.25 inch.

This larva has not yet been bred to the perfect state, but belongs undoubtedly to some one of the Ground-beetles, and not improbably to the Pennsylvania Ground-beetle, (*Harpalus pennsylvanicus*, DeGeer), a dull black species represented at Figure 23. All these Ground-beetles are our friends however, and should always be cherished and not crushed, as they are very apt to be from their habit of crawling and living on the ground. It is safe to infer, that all beetles approaching the annexed form, with active movements, and generally dull colors, which are observed running over the ground, are friends, and should therefore be saved.

[Fig. 23.]

Hogs.—Before leaving the subject of natural remedies, I feel in duty bound to say a few words in favor of hogs as Curculio destroyers. Abundant proof might be adduced of their utility in an orchard, especially during the fruit season, but I will mention only the case of Messrs. Winters Bros., of Du Quoin, Ills. These gentlemen, for the past five years, have kept a large drove of hogs in their extensive peach orchard, and have been remarkably exempt from the attacks of the Little Turk. While at their place last fall, I noticed that all the trees were banked up with earth to the height of over a foot, which prevented the hogs from injuring the trunks. They have never had occasion to shake their trees, and consider one hog to the acre sufficient to devour all the fallen fruit, the hogs being fed only during the winter. The efficacy of this hog remedy depends a great deal on how much one's orchard is isolated from those of others, for it is very evi-

* Explanation of Figure 22.—*B* represents the under side of the head, showing at *c* the upper jaw (*mandible*), at *g* the lower jaw (*maxil*), with its fonr-jointed feelers (*palpi*), at *f* the lower lip (*labium*), with its two-jointed feelers (*palpi*), and at *e* the *antennæ*.

dent that it will avail but little for one person to destroy all his Curculio while his neighbors are breeding them by thousands, so that they can fly in upon him another year. They would also be of but little service in the case of the cherry, as it remains on the tree when stung. Poultry will be found valuable in an orchard as they also devour the grubs which fall with the fruit.

ARTIFICIAL REMEDIES.—Of the hundreds of patent nostrums, and of the dozens of washes and solutions that have been recommended as Curculio preventives or destroyers, there is scarcely one which is worth the time required to speak of it. Air-slacked lime thrown on the trees after the fruit is formed, is effectual in a certain measure, for though it does not deter the female from depositing her eggs, yet so long as the weather is wet, its caustic properties seem to be imparted to the water and enter the cavity and destroy the egg. But it has no good effect in dry weather. An article went the rounds of the papers last Summer, to the effect that Mr. P. E. Rust, of Covington, Ky., had tried burning tobacco stems with *perfect success!* But a letter of inquiry which I addressed to that gentleman was never answered, although it contained the requisite 3-cent postage stamp, and the tobacco remedy may be placed by the side of the Gas-tar and Coal-tar remedies, which have proved utterly useless. After all, as Dr. Hull, suggests, the successes, so reported, of these remedies, take their origin from insufficient experiment, by persons who are little aware of the casualties to which the Curculio is subject, and who, if they happen to get fruit after applying some particular mixture, immediately jump to the conclusion that it was on account of such mixture.

It may therefore be laid down as a maxim, that the only effectual and scientific mode of fighting the Curculio, aside from that of picking up the fallen fruit, is by taking advantage of its peculiar instinct which on approach of danger prompts it to fall; or in other words to catch it by jarring the tree. The most effectual method of doing this on a large scale is by means of Dr. Hull's "Curculio catcher," and I give a description of it in the Doctor's own words:

"To make a curculio catcher we first obtain a light wheel, not to exceed three feet in diameter, the axletree of which should be about ten inches long. We next construct a pair of handles, similar to those of a wheelbarrow, but much more depressed at the point designed to receive the bearings of the axletree, and extending forward of the wheel just far enough to admit a crossbeam to connect the handles at this point; one-and-a-half inches in the rear of the wheel a second cross beam is framed into the handles, and eighteen to twenty-four inches further back, a third. The two last named cross-beams have framed to their under-sides a fourth piece, centrally, between the handles, and pointing in the direction of the wheel. To the handles and to the three last named pieces, the arms or ribs to support the canvass are to be fastened. To the front part of the beam connecting the handles in front of the wheel, the ram is attached, this should be covered with leather stuffed with furniture moss, a dozen or more thicknesses of old hat, leather or other substance, being careful to use no more than necessary to protect the tree from bruising. Ascertain the elevation the handles should have in driving, and support them in that position. We now put in place the stretchers or arms, six for each side, which are to receive and support the canvas. We put the front arms in position. These extend back to near the centre of the wheel on each side, and in front of the wheel (for large machines) say six feet, and are far enough apart to receive the largest tree between them on which it is intended to operate. The remaining arms are supported on the handles, and fastened to them and to the two cross and parallel pieces in the rear of the wheel. These are so placed as to divide the space at their outer ends equally between them and the first mentioned stretchers and fastened to the ends of the handles. Next we have ready a strip of half-inch board two an a half wide. One end of this is secured to the forward end of one of the front arms, and in like manner to all the others on one side of the machine, and fastened to the handles. Both sides are made alike. The office of these strips is to hold the outside ends of the arms in position; they also hold the front arms from closing. These outside strips also receive the outside edge of the canvas, which is fastened to them as well as the several arm supports.

"It will be seen that the wheel is nearly in the center of the machine. To cover the opening at this point, a frame is raised over it, which is also covered with canvas. The arms, or stretchers, are so curved that the motion of the machine, in moving from one tree to another, should bring everything falling on the canvas to depressed points, one on each side of the wheel, where openings are made into funnels emptying into pockets or bags, for the reception of insects and fallen fruit. The whole machine should not exceed ten or eleven feet in breadth, by twelve or thirteen in length. These are for large orchard trees; smaller ones could be protected with a much smaller machine. If the frame work has been properly balanced, the machine will require but little lifting, and will be nearly propelled by its own weight.

"This curculio catcher, or machine, is run against the tree three or four times, with sufficient force to impart a decided jarring motion to all its parts. The operator then backs far enough to bring the machine to the center of the space between the rows, turns round and in like manner butts the tree in the opposite row. In this way a man may operate on three hundred trees per hour."

To run this machine successfully three things are necessary: 1st, that the land be decently clean, and not overgrown with rank weeds; 2d, that the orchard be sufficiently large to pay the interest on the prime cost of the machine—about $30; 3d, that the trees have a clean trunk of some three or four feet. I find various modifications of this machine, both in our own State and in Southern Illinois, and in some instances they have been abandoned entirely on account of the injury caused to the trees from the repeated blows given to the trunk. In small orchards it will be found most profitable to drive a spike into the trunk of each tree and to use two sheets stretched on frames, which can both be dragged or carried and placed in position by one man, while a second person gently taps the iron spike with a mallet. To bring the Curculio down, it requires a light, *sudden* tap which jars, rather than a blow which shakes, and if the frames are each made so as to fold in the middle, it will facilitate disposing of those which fall upon it.

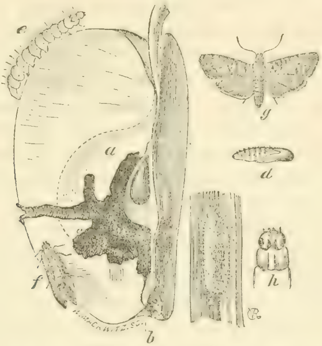
In conclusion, the intelligent fruit-grower can draw many a lesson from this account of the Curculio—already somewhat lengthy. Thus in planting a new orchard with timber surrounding, the less valuable varieties should be planted on the outside, and as the little rascals congregate on them from the neighboring woods in the early part of the season, they should be fought persistently. It will also pay to thin out all fruit that is known to contain grubs, and that is within easy reach; while wherever it is practicable all rubbish and underbrush should be burnt during the winter, whereby many, yes *very many* of them will be destroyed in their winter quarters. As a proof of the value of this measure when it is feasible, I will state that while the peach crop of Southern Illinois was almost an entire failure in 1868, Messrs. Knowles & Co., who have 70 acres of peach orchard 1¼ miles N. W. of Makanda, shipped over 9000 boxes. Though they had a few hogs in the orchard, there were not enough to do any material good, and they think they owe their crop to the fact of having cleared and burnt 100 acres surrounding the orchard, in the early spring of that year; for in 1867 the Curculios had been very bad with them. Judge Kimble, who lives 4 miles N. E. of Cobden, also had a good crop free from their marks, which he attributes to having burnt around the orchard in the spring of the year.

THE CODLING MOTH OR APPLE-WORM—*Carpocapsa pomonella*, Linn.

(Lepidoptera, Tortricidæ.)

The Apple-worm, I find to be quite common all over the State, as it is in almost all parts of the civilized world where apples are grown. Dr. Trimble has devoted page after page to the consideration of this little pest, and yet its whole history and the means of preventing its insidious work may be given in a very few lines. It was originally a denizen of the Old World, but was introduced into this country about the beginning of the present century. The following figure represents it in all its states, and gives at a glance its natural history: *a* represents a section of an apple which has been attacked by the worm, showing the burrowings and channel of exit to the left; *b*, the point at which the egg was laid and at which the young worm entered; *e*, the full

[Fig. 24]



grown worm; *h*, its head and first segment magnified; *i*, the cocoon which it spins; *d*, the chrysalis to which it changes; *f*, the moth which escapes from the chrysalis, as it appears when at rest; *g*, the same with wings expanded. The worm when young is whitish, with usually an entirely black head and a black shield on the top of the first segment. When full grown it acquires a flesh-colored or pinkish tint, especially on the back, and the head and top of first segment become more brown, being usually marked as at Figure 24 *h*. It is sparsely covered with very minute hairs which take their rise from minute elevated points, of which there are eight on each segment. The cocoon is invariably of a pure white color on the inside, but is disguised on the outside by being covered with minute fragments of whatever substance the worm happens to spin to. The chrysalis is yellowish brown, with rows of minute teeth on its back, by the aid of which it is enabled to partly push itself out of its cocoon, when its time to issue as a moth arrives. The moth is a most beautiful object; yet, as has been well remarked by an anonymous writer,* from its habits not being known it is seldom seen in this state, and the apple-grower as a rule, "knows no more than the man in the moon to what cause he is indebted for the basketfuls of worm-eaten windfalls in the stillest weather." Its fore wings are marked with alternate, irregular transverse wavy streaks of ash-gray and brown, and have on the inner hind angle a large tawny brown spot, with streaks of bright bronze color or gold.

The apple is, so to speak, our democratic fruit, and while stone fruit is grown but in certain regions, this is cultivated all over the country. The Codling moth is then even more injurious than the Curculio. Unlike the Curculio, it is mostly two-brooded, the second brood of worms hybernating in the larval state, inclosed in their snug

* Entomological Magazine, London, Vol. I, p. 144.

little silken houses, and ensconced under some fragment of bark or other shelter. The same temperature which causes our apple trees to burst their beauteous blossoms, releases the Codling moth from its pupal tomb, and though its wings are at first damp with the imprint of the great Stereotyping Establishment of the Almighty, they soon dry and expand under the genial spring-day sun, and enable each to seek its companion. The moths soon pair, and the female flits from blossom to blossom, deftly depositing in the calyx of each a tiny yellow egg. As the fruit matures, the worm develops. In thirty-three days, under favorable circumstances, it has become full-fed; when, leaving the apple, it spins up in some crevice, changes to chrysalis in three days, and issues two weeks afterwards as moth, ready to deposit again, though not always in the favorite calyx this time, as I have found the young worm frequently entering from the side. Thus the young brood of Codling moths appear at the same time as the young Curculios, the difference being that instead of living on through fall and winter, as do the latter, they deposit their eggs and die, it being the progeny from these eggs which continues the race the ensuing year. Though two apples side by side may, the one be maturing a Curculio, the other a Codling moth, the larva of the latter can always be distinguished from the former by having six horny legs near the head, eight fleshy legs in the middle of the body, and two at the caudal extremity, while the Curculio larva hasn't the first trace of either.

In latitude 38° the moths make their appearance about the first of May, and the first worms begin to leave the apples from the 5th to the 10th of June and become moths again by the fore part of July. While some of the first worms are leaving the apples, others are but just hatched from later deposited eggs, and thus the two broods run into each other; but the second brood of worms (the progeny of the moths which hatch out after the first of July), invariably passes the winter in the worm or larval state, either within the apple after it is plucked, or within the cocoon. I have had them spin up as early as the latter part of August, and at different dates subsequently till the middle of November, and in every instance, whether they spun up early or late in the year, they remained in the larval state till the middle of April, when they all changed to chrysalids within a few days of each other. Furthermore, they not only remain in the larval state, but in many instances where I have had them in a warm room, they have been *active* throughout the winter, and would always fasten up the cuts made in their cocoons, even where the operation was performed five and six times on the same individual. These active worms perfected themselves in the spring as well as those which had not been disturbed, and this fact would indicate that the torpid or dormant state, so called, is not essential to the well being or the prolongation of life of some insects.

Though the Codling moth prefers the apple to the pear, it nevertheless breeds freely in the latter fruit, for I have myself raised the moth from pear-boring larvæ, and the fact was recorded many years, ago by the German entomologist, Kollar. It also inhabits the fruit of the crab-apple and quince, and is not even confined to pip-fruit, for Dr. T. C. Hilgard, of St. Louis, bred a specimen, now in my cabinet, from the sweetish pulp of a species of screw-bean (*Strombocarpa monoica*) which grows in pods, and which was obtained from the Rocky Mountains, while Mr. Wm. Saunders, of London, Ontario, Canada, has also found it attacking the plum in his vicinity.* This is entirely a new trait in the history of our Codling moth, and is another evidence of the manner in which certain individuals of a species may branch off from the old beaten track of their ancestors. This change of food sometimes produces a change in the insects themselves, and it would not be at all surprising, if this plum-feeding sect of the Codling moth, should in time show variations from the normal pip-fruit feeding type. As Mr. Saunders is a well known entomologist, it is not likely that he has been mistaken in the identification of the species, for the only other worm of this character which is known to attack the plum in America, is the larva of Mr. Walsh's Plum moth (*Semasia prunivora*) which is a very much smaller insect than the Codling moth. Mr. Saunders says that his plum crop suffered considerably from this cause and that the operation appeared to be performed by the second brood, the plums falling much later than those stung by the Curculio—remaining in fact on the tree till nearly ripe. I do not think that this insect has yet acquired an appetite for the plum in the States. As a general rule, there is but a single worm in each apple, but two are sometimes found in one and the same fruit.

Remedies.—Though with some varieties of the apple, the fruit remains on the tree till after the worm has left it, yet by far the greater portion of the infested fruit falls, prematurely with the worm, to the ground; hence much can be done toward diminishing the numbers of this little pest by picking up and destroying the fallen fruit as soon as it touches the ground. For this purpose, hogs will again be found quite valuable, when circumstances allow of their being turned into the orchard. Abundant testimony might be given to prove this, but I make room only for the following from Mr. Suel Foster, of Muscatine, Iowa, whom I know to be abundantly capable of forming a proper judgment:

"I have twenty-four acres of my orchards seeded to clover, and last year I turned the hogs in. I now observe that where the hogs ran last year, the apples have not one-fourth the worms that they have on other trees. I this year turned the hogs into my oldest (home) orchard.†"

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* Report of the Commissioner of Agriculture and Arts, of the Province of Ontario, for the year 1868, page 200.

† Transactions Illinois State Horticultural Society, 1867, page 213.

Mr. Huron Burt, of Williamsburg, Mr. F. R. Allen, of Allenton and Mr. Varnum, of Sulphur Springs, have also, each of them, testified to me as to the good effects obtained from allowing hogs the run of their orchards.

There is, however, a more infallible remedy, and one which is always practicable. It is that of entrapping the worms. This can be done by hanging an old cloth in the crotches of the tree, or by what is known as Dr. Trimble's hay-band system, which consists of twisting a hay-band twice or thrice around the trunk of the tree. To make this system perfectly effectual, I lay down the following as rules: 1*st*, *the hay-band should be placed around the tree by the first of June, and kept on till every apple is off the tree*; 2*d*, *it should be pushed up or down, and the worms and chrysalids crushed that were under it, every week, or at the very latest, every two weeks*; 3*d*, *the trunk of the tree should be kept free from old rough bark, so as to give the worms no other place of shelter, and*, 4*th*, *the ground itself should be kept clean from weeds and rubbish.* But, as already stated on a previous page, many of the worms of the second brood yet remain in the apples even after they are gathered for the market. These wormy apples are barrelled up with the sound ones, and stored away in the cellar or in the barn. From them the worms continue to issue, and they generally find plenty of convenient corners about the barrels in which to form their cocoons. Hundreds of these cocoons may sometimes be found around a single barrel, and it therefore becomes obvious that, no matter how thoroughly the hay-band system had been carried out during the summer, there would yet remain a sufficiency in such situations to abundantly continue the species another year. And when we consider that every female moth which escapes in the spring, lays from two to three hundred eggs, and thus spoils so many apples, the practical importance of thoroughly examining, in the spring of the year, all barrels or other vessels in which apples have been stored becomes at once apparent. It should, therefore, also be made a rule to destroy all the cocoons which are found on such barrels or vessels either by burning them up or by immersing them in scalding hot water.

Now, there is nothing in these rules but can be performed at little trouble and expense. Their execution must henceforth be considered a part of apple-growing. Let every apple-grower in Missouri carry them out strictly, and see that his neighbors do likewise, and fine, smooth, unblemished fruit will be your reward!

The philosophy of the hay-band system is simply that the worms, in quitting the fruit, whether while it is on the tree or on the ground, in their search for a cozy nook, in which to spin up, find the shelter given by the hay-band just the thing, and in ninety-nine cases out of a hundred, they will accept of the lure, if no other more enticing be in their way. I have thoroughly tested this remedy the past summer, and have found it far more effectual than I had anticipated, wherever the above rules were recognized. Under two hay-bands which were kept around a single old isolated tree, through the months of June, July and August, I found every week of the last two months an average of fifty cocoons.

I have often smiled in my journeyings through the State, to see the grin of incredulity spread over the face of some unsophisticated farmer as I recounted the natural history of this Codling moth, and urged the application of the hay-band. Magic spell or fairy tale could not more thoroughly have astounded some of them than the unmasking of this tiny enemy and the revealing of the proper preventive.

The burning of fires has been recommended, under the supposition that the moths will fly into them and get destroyed. I have no faith whatever in the process, so far as regards this particular species, for though it is true that the moths fly and deposit their eggs in the evening, I do not believe they are attracted to the light, as are some others, for I have never been able to thus attract any myself.

CUT-WORMS.

(Lepidoptera Noctuidæ.)

THE NATURAL HISTORY OF TWELVE DISTINCT SPECIES.

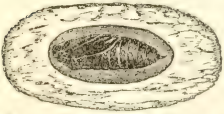
There are several different kinds of insects that are known by the popular name of cut-worm. Thus, the White grub, or larva of the common May beetle (*Lachnosterna quercina*, Knoch), and the different species of wire-worms, the larvæ of our Click beetles (*Elater* family) are all called cut-worms in some part or other of the United States. But I shall confine the term to those caterpillars, which, for the most part, have the habit of hiding just under the surface of the earth during the day, and feeding either on the roots, stems or leaves of plants during the night.

Most of these caterpillars have the very destructive habit of cutting, or entirely severing the plant on which they feed, just above or below the ground. On this account they have received the name of *Cut*-worms, and not because when cut in two, each end will reproduce itself as some people have supposed; for although some polyps and other animals belonging to the great class RADIATA in the animal kingdom, have this curious power of multiplying by division, it is not possessed by any insect, and after having mutilated one of these cut-worms, the farmer need never fear that he has thereby increased, instead of having decreased their number. From this habit of cutting, they prove a far greater nuisance than if they were to satisfy their appetites in an honest manner. In the latter case we might feel like letting them go their way in peace, but as with the Baltimore oriole, which abrades and ruins a hundred grapes where it would require one for food, we feel vexed at such wanton destruction of our products, and would gladly rid ourselves of such nuisances.

These caterpillars are called surface caterpillars in England, in which country, as well as on the continent of Europe, they have long been known to do great damage to vegetables, and especially to the cabbage, mangel-wurzel and turnip. There are many different species and they vary in size and detail of markings; but all of them are smooth, naked and greasy-looking worms of some shade of green, gray, brown or black, with a polished, scaly head, and a shield of the same color on the top of the first and last segments; while most of them have several minute shiny spots on the other segments, each spot giving rise to a minute stiff hair. They also have the habit of curling up in a ball when disturbed, as shown at Figure 2, in Plate 1. They produce moths of sombre colors which are known as Owlet or Rustic moths, and the species that have so far been bred in this country, belong to one or other of the four genera, *Agrotis*, *Hadena*, *Mamestra* or *Celæna*. These moths fly, for the most part by night, though some few of them may be seen flying by day, especially in cloudy weather. They frequently, even in large cities, rush into a room, attracted by the light of gas or candle, into which they heedlessly plunge and singe themselves. They rest with the wings closed more or less flatly over the body, the upper ones entirely covering the lower ones, and these upper wings always have two, more or less distinctly marked spots, the one round, the other kidney-shaped.

The natural history of most of these cut-worms may be thus briefly given. The parent moth attaches her eggs to some substance near the ground, or deposits them on plants, mostly during the latter part of summer, though occasionally in the spring of the year. Those which are deposited during late summer, hatch early in the fall, and the young worms, crawling into the ground feed upon the tender roots and shoots of herbaceous plants. At this time of the year, the worms being small and their food plentiful, the damage they do is seldom noticed. On the approach of winter they are usually about two-thirds grown, when they descend deeper into the ground, and, curling themselves up, remain in a torpid state till the following spring. When spring returns, they are quite ravenous, and their cutting propensities having fully developed, they ascend to the surface and attack the first green succulent vegetation that comes in their way. When once full grown they descend deeper into the earth, and form for themselves oval chambers, in which they change to chrysalids, as shown in the annexed cut (Fig. 25). In this state they remain from two to four weeks, and finally come forth as moths, during the months of June, July and August, the chrysalis skin, being in most cases so thin, that it is impossible to preserve it. These moths in time lay eggs, and their progeny goes through the same cycle of changes. Some species, however, as I shall presently show, are most likely two-brooded, while others pass through the winter in the chrysalis state.

[Fig. 25].



Dr. Fitch states that he had great difficulty in breeding these cut-worms to the perfect moths, "as the worms on finding themselves imprisoned, hurriedly crawl around and around the inner side of their prison, night after night, until they literally travel themselves to death." Consequently the natural history of but one or two of them has hitherto been known. I have found, however, that by giving them the proper conditions they are not so very difficult to breed, and after giving some account of a certain class of cut-worms which have the habit of climbing up trees, I will briefly describe those species which I have traced through their transformations, so that they may be readily recognized, and afterwards suggest the proper remedies.

CLIMBING CUT-WORMS.

Orchardists in spring frequently find the hearts of their fruit buds—on young trees especially—entirely eaten out and destroyed, and this circumstance is attributed to various causes, winged insects, beetles, slugs for instance; or even to late frosts, unsuitable climate, etc. Never have cut-worms received the blame, all of which should be ascribed to them, for the game hold of many species on a sandy soil in early spring, is the fruit tree. This is a very important fact to fruit raisers, and let those who have essayed to grow the dwarf apple and pear, on a sandy soil, and have become discouraged, as many have, from finding their trees affected each year in this way, take hope; for knowing the cause, they may now easily prevent it.

These climbing cut-worms will crawl up a tree eight or ten feet high, and seem to like equally well the leaves of the pear, apple and grape.

They work during the night, always descending just under the surface of the earth again at early dawn, which accounts for their never having been noticed in this their work of destruction in former years. They seldom descend the tree as they ascend it, by crawling, but drop from the bud or leaf on which they have been feeding; and it is quite interesting to watch one at early morn when it has become full fed and the tender skin seems ready to burst from repletion, and see it prepare by a certain twist of the body for the fall. This fact also accounts for trees on hard, tenacious soil, being comparatively exempt from them, as their instinct doubtless serves them a good turn either in preventing them from ascending or by leading the parent moth to deposit her eggs by preference on a light soil.

These facts were published in the *Prairie Farmer* of June 2, 1866, accompanied with descriptions by myself of three of the worms that were found to have this habit; and the observations were made on Mr. J. W. Cochran's farm at Calumet, Illinois. In speaking of these same climbing cut-worms, in the same article Mr. Cochran says:

"They destroy low branched fruit trees of all kinds, except the peach, feeding on the fruit buds first, the wood buds as a second choice, and preferring them to all other things, tender grape buds and shoots (to which they are also partial) not excepted—the miller always preferring to lay her eggs near the hill or mound over the roots of the trees in the orchard; and if, as is many times the case, the trees have a spring dressing of lime or ashes with the view of preventing the May beetles' operations, this will be selected with unerring instinct by the miller, thus giving her larvæ a fine warm bed to cover themselves up in during the day from the observations of their enemies. They will leave potatoes, peas and all other young green things for the buds of the apple and the pear. The long, naked young trees of the orchard are almost exempt from their voracious attacks, but I have found them about midnight, of a dark and damp night well up in the limbs of these. The habit of the dwarf apple and pear tree however just suits their nature, and much of the complaint of those people who can not make these trees thrive on a sandy soil, has its source and foundation here, though apparently utterly unknown to the orchardist. There is no known remedy; salt has no properties repulsive to them, they burrow in it equally as quick as in lime or ashes. Tobacco, soap and other diluted washes do not even provoke them; but a tin tube 6 inches in length, opened on one side and closed around the base of the tree, fitting close and entering at the lower end an inch into the earth, is what the lawyers would term an effectual estopper to further proceedings.

"If the dwarf tree branches so low from the ground as not to leave 6 inches clear of trunk between the limbs and ground, the limbs must be sacrificed to save the tree—as in two nights four or five of these pests will fully and effectually strip a four or five year old dwarf of every fruit and wood bud, and often when the tree is green, utterly denude it of its foliage. I look upon them as an enemy to the orchard more fatal than the canker worm when left to themselves, but fortunately for mankind more surely headed off."

Harris gives us the earliest intimation of this climbing character in these worms, on page 450 of his work, where he says, that "in the summer of 1851, an agricultural newspaper contained an account of certain naked caterpillars, that came out of the ground in the night, and crawling up the trunks of fruit-trees, devoured the leaves, and returned to conceal themselves in the ground before morning." But until the above article, from which I have quoted, was published, the fact was not generally known and none of the species had been identified.

They seem to prefer the apple, pear and grape-vine, though they also attack the blackberry, raspberry, currant, and even rose-bushes and ornamental trees. Nor do they confine themselves to dwarf trees, as the following extract from a letter by John Townley, of Marquette Co., Wis., to the *Practical Entomologist* for March, 1867, abundantly proves.

"During the last two years at least, young apple-trees in this locality have been much injured by having their buds destroyed. My observations last spring led me to conclude, that a worm very like the cut-worm, and having the same habit of hiding just beneath the surface of the soil during the day and feeding by night, was the cause of the mischief. * * * * * *

"Soon after snow had gone in 1865, I pruned a lot of apple-trees then four years planted. The wood at the time seemed alive and sound. When older trees were coming into leaf, these remained almost destitute of foliage; and on examining them, it was found, that most of the buds, especially those on shoots formed the preceding year, were gone—removed as clean as if they had been picked out with a point of a knife. The bark in small patches near the ends of some of the shoots had also been eaten or chipped off. As many small birds had been seen about the trees, the conclusion was arrived at that they had probably eaten the buds. In the fall, mounds of earth were thrown up around the stems of these trees, and of another lot two years planted. These mounds were being leveled on the 6th of May last; and soon after commencing the work, several large cut-worms like grubs were noticed. This, coupled with the fact, that in the preceding spring, I had caught a worm like these in the very act of eating out a bud high up the stem of a young Catalpa, around which I had thrown a blanket the evening before, to shield it from frost, induced me to suspect that they and not the birds destroyed the buds. This led to an examination of the untouched mounds; and in the soil immediately surrounding the stem of each tree, I found from about five to ten of these worms. Twenty-three were taken from the soil around a plant of the Rome Beauty apple. * * * On a warm dewy night about the middle of the month, I took a lamp and suddenly jarred several of the trees; when some of these worms came tumbling to the ground. The evidence against them would have been more conclusive, if I had searched the branches and found them there and at work. That however, I omitted to do. I have had fruit trees planted here sixteen years, but never had the buds destroyed so as to attract my attention before the last two years; nor have I had any complaints from my neighbors on this point, except during that time. Orchards are not very common here, but in three others in this town, I know young trees have been injured as in my own during the last two years. * * * I grow no dwarf apples; mine are all standard trees worked on the ordinary apple stock."

Mr. Cochran also found them last spring, up among the highest branches of his standard as well as his dwarf trees.

The subject is all important to the orchardist, and to those especially who have young and newly planted trees on a light soil; for there are many who have had their trees injured by the buds being devoured in this manner, who never dreamed of preventing such an occurrence, for the reason that the mischief was attributed to birds. Thus our Quail, Purple-finch, and many other birds, have too often unjustly received the execrations of the culturist, which that evil genius the cut-worm, alone deserved. To understand an enemy's foible is to have conquered, and when we learn the source of an evil it need exist no longer. The range of these climbing worms seems to be wide, for we have undoubted evidence of their attacking the grapevine, even in California, and I have found two species in Missouri, which have the same habit. Climbing cut-worms frequently have the same habit of severing plants, as those which have never been known to climb, and I very much incline to believe that this habit is only acquired in the spring time, and most cut-worms will mount trees if they are forced to do so, by the absence of herbaceous plants.

THE VARIEGATED CUT-WORM.—Pl. 1, Figs. 1, 2, 3 and 4.

(Larva of the Unarmed Rustic, *Agrotis inermis*, Harris.)

During the latter part of May, Mr. Isidor Bush, of Bushburg, Mo., brought me several greasy-looking worms, which had been feeding on, and doing considerable damage to a lot of young Creveling grapevines, which he had in cold frames. As I ascertained afterwards, upon visiting Mr. Bush's place, they lay concealed during the day, just under the surface of the rich earth, contained in the frames, and mounted the vines to feed, during the night time. The weather being warm, Mr. B. at my suggestion, threw open the frames during the day and allowed the chickens to get in them, and two days after doing this, there was not a worm to be found. By the 30th of May, these worms had grown to be of great size, measuring nigh two inches in length. When full grown they are mottled with dull flesh-color, brown and black, with elongated, velvety-black marks each side, as shown at Plate 1, Figure 2. The head is light gray and mottled, and marked as shown in Figure 3, and each segment on the back appears as in Figure 4 of the same plate.

About the time these worms were completing their growth, they having most likely developed earlier than usual, in the unnatural heat of the frames, I received from J. M. Shaffer, Secretary of the Iowa State Agricultural Society, some eggs which he found on a cherry twig. These eggs were quite small, of a pink color, with ribs radiating from a common centre, and were deposited in a batch. Exactly similar eggs, found on an apple twig, were presented to the Alton Horticultural Society, at its June meeting, by Mr. L. W. Lyon, of Bethalto, Ills.; while I subsequently found a batch of the very same eggs on a White mulberry LEAF, taken from a tree growing near St. Louis. Between the 24th and 30th of May, the young hatched from these eggs, in the shape of minute, thread-like worms of a dirty yellow color, and covered with the spots, already spoken of as occurring on all cut-worms, which are at this time in this species quite dark and conspicuous. In this early stage of their growth, they did not hide themselves in the ground, and had, furthermore, the peculiarity of looping up the back when in motion, in the same manner as does the Canker-worm, and as do all other geometers or span worms. After the first moult, which took place six days after hatching, the dark spots became almost obliterated, the characteristic markings of this same Variegated cut-worm which I had received from Mr. Bush, began to appear, and they lost their looping habit. At this time they grew at an incredible rate, becoming thicker in proportion to their length as they grew older, and by the 15th of June, those which hatched on the 24th of May, had shed their skins four times, and gone into the ground, where they formed oval cocoons of earth, and in two days more were changed into chrysalids. By the 20th of June the moths began issuing, thus requiring but 35 days to go through all their transformations.

These worms were very voracious, and after the first moult, showed the true cut-worm characteristic of concealing themselves during the day, and feeding at night. Moreover, they proved to be quite universal feeders, for while I fed them, when young, on cabbage and grapevine leaves, they flourished exceedingly, the latter part of their lives, on the leaves of the White mulberry; and on the 16th of June, I dug up from my garden, two full grown specimens of this same kind of worm, which produced the same species of moth, each of them having severed a young lettuce plant. From the foregoing, it is manifest that all cut-worm moths do not deposit their eggs on the ground, and from the fact that these eggs were found, in one instance, on a leaf, so early in the season, they were undoubtedly deposited in the spring by a moth which must have passed the winter either in the chrysalis or moth state; and as the insect goes through its transformations so rapidly, there are most likely two broods during the year. From the foregoing experience, and from the fact that most other moths attach their eggs to different substances, I think it not unlikely that our cut-worm moths do the same, as a general rule, instead of depositing them in, or on the ground, as has heretofore been supposed; and Mr. Cochran has related to me a curious incident which bears me out in this belief. He is in the habit of gathering, during the winter, all crumpled leaves and egg-masses which he finds in his orchard, and of placing them in a drawer in his secretary. Last spring he was astonished to find several half-grown cut-worms in this drawer, they having evidently hatched from some of the eggs, and fed entirely on some apples which chanced at that time to be in the drawer.

The moth produced from this cut-worm is represented at Plate 1, Figure 1. Its general color is a dark brownish-gray, some specimens being almost black along the front edge of the upper wings, while others have this edge of a dull golden-buff color. The NOCTUIDÆ, to which our cut-worm moths belong, have not yet been worked up by any one in this country, and as they are all of sombre colors, and as the species, in many instances, very closely resemble each other, it is not an easy matter to properly determine them. The species under consideration, is apparently quite common here, and yet Mr. A. Grote of New York, who made a trip to Europe last year, for the purpose of comparing our American moths with those in the British museum, and in other European collections, took a specimen with him and brought it back unnamed. In the collection of Mr. A. Bolter, of Chicago, it is marked *Agrotis saucia*, Treitschke, while Mr. Cresson informs me that in the collection of the American Entomological Society, at Philadelphia, it is named *æqua*, but without authority. Harris's description of *inermis* (Inj. Insects, p. 444), brief and insufficient as it is, agrees with some of the individuals, and, as it is said to be the counterpart of *æqua* which is an European species, I have concluded, rather than to create more synonyms, to redescribe it below, under this name. Individuals among the numerous specimens which I bred from the same batch of eggs, differ greatly from one another, and I find this to be the case with all owlet moths. Indeed, with the present species, a description taken from any single specimen would scarcely suffice for any of the others, and it is not at all unlikely that this species has received different names from different authors.

AGROTIS INERMIS, Harris—*Larva*—Length, when full grown, 2 inches. Finely mottled with dull, carneous-brown and black, and having dark velvety longitudinal marks along subdorsal and stigmatal region (see Pl. 1, Fig. 2); segment 11 somewhat ridged and abruptly divided transversely by velvety black and carneous. Lighter laterally than above. A carneous stripe below stigmata. Venter and legs speckled glaucous. Dorsum of segments marked as in Plate 1, Figure 4; Head light gray, and marked as in Plate 1, Figure 3. Cervical shield obselete.

Chrysalis.—Of normal form, deep mahogony brown, with a single point at extremity.

Perfect insect.—Average length 0.80; alar expanse 1.80. Ground color of fore wings gray-brown, marked as in Plate 1, Figure 1. A most variable species, sometimes washed with dull carneous, at others with light buff, but always marked with more or less smoky black. Costal region, head and thorax, sometimes very black, at others bright golden-buff. Spots usually lighter than wing, though sometimes concolorous. Basal half and transverse lines more or less distinct, especially at costa, geminate, their middle space, usually lighter than the ground color. Hind wings pearly white, with a very slight pink tint in the middle, shaded behind and veined with smoky brown.

Under surface of the wings, the least variable and most characteristic feature, that of fore-wings being mouse-gray with a distinct ferruginous spot in the middle at base, and a lighter strip running from this spot to the posterior angle; the arcuated band very distinct and geminate at costa, and the whole surface pearly and especially the light strip at interior margin, which in certain lights reflects all the prismatic colors. That of hind wings pearly white in the middle, darker near the margins, distinctly freckled along anterior margin, where the arcuated band is very distinct, while in the middle of the wing it is represented by distinct black strokes on the veins.

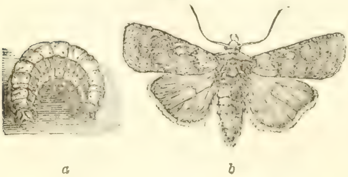
Described from 25 bred specimens.

THE DARK-SIDED CUT-WORM.

(Larva of the Cochran Rustic, *Agrotis Cochranii*, Riley.)

This worm is one of the most common of those which have the climbing habit. It is represented in the annexed Figure 26, at *a*.

[Fig. 26.]



a *b*

The general color is dingy ash-gray, but it is characterized more especially by the sides being darker than the rest of the body. When young, it is much darker, and the white, which is below the dark lateral band, is then cream-colored, and very distinct. It produces a moth which may be known as the Cochran Rustic, and was first described in the *Prairie Farmer* of June 22, 1867. Speaking of the depredations of this worm, Mr Cochran says:

"In the beginning of the evening its activity is wonderful; moving along from limb to limb swiftly, and selecting at first only the blossom buds, to one of which having fastened, it does not let go its hold until the entire head is eaten out, and from this point, so thorough is its work, no latent or adventitious bud will ever again push. From a six-year old fruit tree, I have, on a single night, taken seventy-five of these worms, and, on the ensuing evening, found them well nigh as plenty on the same tree. When all the blossom buds of a tree are taken, it attacks with equal avidity the leaf buds. It is no unusual thing to find small trees with every bud that had pushed, from first intentions utterly destroyed, and frequently young orchards the first season planted on sandy grounds, lose from 50 to 75 per cent. of their trees; sometimes those remaining will be so badly injured as to linger along for a few years, fruiting prematurely each season, and then die, utterly drained of their vital principle by this dreadful enemy. The instinct of the perfect insect, like that of all insects injurious to vegetation, leads it unerringly to deposit its eggs where they will hatch out from the warmth of the sun, and where the larvæ is nearest to that food which is necessary to its existence: hence I never yet have found the eggs upon clay, or heavy cold grounds of any description, and on my carefully placing them in such situations they failed to hatch out. Can there be a stronger argument used for the appointment of a State Entomologist than the fact, that the habits of this enemy of horticulture, that has ruined millions of dollars worth of fruit trees in our country, has until recently been entirely unknown? I doubt whether one fruit grower in five hundred is even now aware of the presence of this curse on his grounds. There is not an orchard upon the sands of Michigan, or the light timber openings of Indiana, or the sandy ridges of our own State, but that has suffered greatly, many of them entirely ruined by its depredations. It is far more destructive to fruit trees than any other insect, infinitely more so than the canker worm, but unlike the other depredators of our orchard trees, it is easily kept in check, and at small expense permanently eradicated."

This species remains longer underground in the chrysalis state, than the preceding, and there is but one brood each year, the moths appearing through the months of July and August. The moth which is represented at Figure 26, *b*, is of a light warm gray color, and shaded with brown and umber.

Agrotis Cochranii, Riley—*Imago.*—Fore wings of a light warm cinereous, shaded with vandyke brown and umber, the terminal space, except at apex, being darker and smoky. Basal, middle and limbal areas of almost equal width, the middle exceeding somewhat the others. A geminate dark basal half-line, usually quite distinct. Transverse anterior geminate, dark, somewhat irregularly undulate, and slightly obliquing outwards from costa to interior margin. Transverse posterior geminate, the inner line being dark, distinct and regularly undulate between the nerves, while the outer line is plain and much paler; it is arcuated superiorly and inversely obliques for two-thirds its width. Orbicular and reniform spots of normal shape, having a fine, dark annulation, which is however obsolete in both, anteriorly; the orbicular is concolorous with the wing, whilst the reniform has a dark inner shade with a central light one, and forms with the transverse posterior a somewhat oval spot which is also dark. Median shade dark and distinct interiorly, shading off and becoming indistinct in center of wing, and quite dark between the two spots, giving them a fair relief. Subterminal line single, light, acutely and irregularly dentate, with an inner dark shade, but warmer than that of terminal space. Terminal line very fine, almost black, slightly undulate. Fringes of same color as wing, with a light central line, having an outer dark coincident shade. A dark costal spot in basal area; at termini of the usual lines, and two light ones in subterminal space. In some specimens one or two fine dark sagittate marks are discernable, and also a fine black claviform mark. Hind wings: whitish, with a darker shade along posterior margin. Under surface of fore wings somewhat lighter than the upper surface and pearlaceous interiorly, with a smoky arcuated band—more definite near the costa than elsewhere—and a tolerably distinct lunule. Under surface of hind wings concolorous; slightly irrorate with brown anteriorly and posteriorly, and with an indistinct lunule and band. Antennæ, prothorax, thorax, tegulæ and body of same color as primaries, the prothorax having a darker central line, and in common with the tegulæ a carneous margin. Under surface lighter; legs with the tarsi spotted.

This moth, in its general appearance, bears a great resemblance to *Hadena chenopodii*, but the two are found to differ essentially when compared. From specimens of *H. chenopodii*, kindly furnished me by Mr. Walsh, and named by Grote, I am enabled to give the essential differences, which are: 1st. In *A. Cochranii*, as already stated, the middle area exceeds somewhat in width either of the other two, while in *H. chenopodii* it is but half as wide as either. 2d. In the *Agrotis* the space between the spots and between the reniform and transverse posterior is dark, relieving the spots and giving them a light appearance, whilst in the *Hadena* this space is of the same color as the wing, and the reniform spot is dark. The claviform spot in the *Hadena* is also quite prominent, and one of its distinctive features, while in the *Agrotis* it is just about obsolete.

There are specimens that seem to be intermediate between these two, but all those bred by me, both male and female, were quite constant in their markings, and their intermediates will doubtless prove to be distinct species or mere varieties.

Larva—Length 1.07 inches. Slightly shagreened. General color, dingy ash-gray, with lighter or darker shadings. Dorsum light, inclining to flesh color, with a darker dingy line along its middle. The sides, particularly along the sub-dorsal line are of a darker shade. On each segment there are eight small, black, shiny, slightly elevated points, having the appearance of black sealing-wax, from each of which originates a small black bristle. The stigmata are of the same black color, and one of the black spots is placed quite close to them anteriorily. Head shiny and of the same dingy color as the body, with two darker marks, thick and almost joining at the upper surface, becoming thinner below and diverging toward the palpi. The upper surface of first segment is also shiny like the head. Ventral region of the same dingy color, but lighter, having a greenish tinge anteriorly and inclining to yellow under the anal segment. Legs of same color. It has a few short bristles on the anterior and posterior segments.

Chrysalis.—Length 0.70 of an inch. Light yellowish brown with a dusky line along top of abdomen. Joints, especially of the three segments immediately behind the wing-sheaths, dark brown. The brown part of these three segments, minutely punctured on the back. Eyes dark brown, and just above them, a smaller brownish spot. Two quite minute bristles at extremity.

Described from numerous bred specimens.

THE CLIMBING CUT-WORM—Pl. 1, Figs. 5, 6 and 7.

(Larva of the Climbing Rustic, *Agrotis scandens*, N. Sp.)

This is another of the most common species having the climbing habit. It occurs in at least five different States, for Mr. Walsh informs me that it is the species referred to by Mr. Townley, of Marquette county, Wisconsin, and I have found it with the same pernicious habit on Mr. Jordan's nursery at St. Louis, in our own State; while it was even more numerous, last spring, in North Illinois, North Indiana and West Michigan, than the preceding species, as I am informed by Mr. Cochran, and by Mr. H. D. Emery, of Chicago, who both sent me great numbers of specimens during the last week of April. The following interesting letter accompanied those which were received from the last named gentleman:

"I made a nocturnal visit to Mr. Cochran's place, Monday night, for the purpose of observing the workings of this pest, and spent about 3½ hours, until 1 o'clock in the morning, at the job. I found on some single dwarf trees over 50 at a time, and from that down, and they were on both apple, pear, peach and cherry. They commence ascending the trees soon after dark, and are found the most plenty from 11 to 12, some remaining on the trees until daylight, as I found several at 4 o'clock in the morning. Their first drive seems to be the terminal bud, and when these are all gone, they take side buds or even the bark of the tree in many cases, as you will see by the small twigs sent herein. You will see they are of different sizes. Some trees were entirely despoiled of the terminal buds. After they have eaten their fill, they seem to let themselves off the limb by a short web, and drop to the ground. We have found a large number of the worms attacked by the bug found in the tin box*. They would pierce the worm and suck him dry, and frequently two of them were hold of one worm. There were also numbers of spiders about the trees, of various sizes and kinds, all alive and alert, and apparently annoying if not preying upon the worms. Also a beetle, of which I send two specimens, was very active on the ground under the trees, apparently after prey †. The worms were the most abundant on the light sandy soils, and less frequent as the ground grew hard or clayey, and where it was pretty much all clay, scarcely one could be found. The tin tubes placed around the trunks of the trees, when properly adjusted, were a perfect protection. The injury they have already done is very great."

Mr. Cochran, speaking of the same worm, says: "Some trees were literally covered with them. Scarcely a bud but that had its worm, and, returning towards 10 o'clock, to those trees which we had in the early part of the night examined, we found others had come as abundantly as before. I have observed that they are actually ruining the young orchards along the Lake shore, and, strange as it may appear, their owners do not know what is doing the mischief. At Hyde park, where there are many handsome country residences with grounds of great beauty, this worm has been especially injurious to their young shrubbery."

This worm is represented at Plate 1, Figure 7. Its general color is a very light yellowish-gray, variegated with dirty bluish-green, and when filled with food it wears a much greener appearance than otherwise. In depth of shading it is variable however, and the young worm is of a more uniform dirty whitish-yellow, with the lines along the body less distinct but the shiny spots more so than in the full

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* The bug was the Spined Soldier bug. (*Arma spinosa,* Dallas). See Figure 54.

† The Incrassated Geopinus (*Geopinus incrassatus,* Dej.) a beetle about ½ inch long and of the color and polished appearance of thin glue.

grown ones. Mr. Cochran informs me that on the apple tree, when this worm has fed out its bud, the work is so effectually done, that no adventitious or accessory bud ever starts again from the same place; the worm, as it were, boring into the very heart of the wood and effectually destroying the ability of the tree to react, at such a point, in the formation of a new bud, and that consequently a tree that is once stripped generally dies, and that this occurs more frequently on small or dwarf trees, where the buds are few, and 3 or 4 worms in a single night can eat out every one. But I have noticed that with the grape-vine this is not generally the case, as a new bud almost always appears where one has been eaten off.

Great numbers of these worms which I reared to the moth state, were fed promiscuously on apple and grape-vine leaves. They began entering the earth on the 20th of May, and generally issued as moths nine days after thus disappearing; the last moth having issued on the 29th of June.

The moth produced from this worm is easily distinguished from most other owlet moths by its peculiar color. It seems allied to *Agrotis cursoria* of Europe, and also greatly resembles one that was described as *A. murænula*, by Mr. Grote, and figured in Volume 1, Number 4, of the American Entomological Transactions. Upon submitting specimens to Mr. Grote, however, he informed me that it is distinct and undescribed, and I have therefore named it the Climbing rustic (*Agrotis scandens*). It is well represented with extended wings at Plate 1, Figure 5, and with closed wings at Figure 6. The general color of the upper wings is a pearly bluish-gray, while the under wings are pearly white; but as with the other species, it varies greatly in color and appearance, and as I could pick out, from 30 individuals, at least 4 which, if taken singly would doubtless be described as distinct species, it is not unlikely that Mr. Grote's *murænula*, may prove identical with it after all.

AGROTIS SCANDENS, N. Sp.—*Larva.*—Average length when full grown 1.40. Ground-color very light yellowish gray, variegated with glaucous in the shape of different sized patches, which are distinctly seen under the lens, to be separated by fine lines of the light ground color. A well defined dorsal and less distinct subdorsal and stigmatal line, caused by these patches becoming larger and darker; another and still less distinct line of the same kind under stigmata. The dorsal line frequently with a very fine white line along its middle, especially at sutures of segments. Piliferous spots in the normal position; those above black, those at the sides lighter. Stigmata black. Head and cervical shield tawny, the latter with a small black spot each side, the former with two in front, and two eye-spots each side. Caudal plate tawny, speckled with black. Venter and legs glaucous. Bristles fine and small. Filled with food it wears a much greener appearance than otherwise, while when young it is of a more uniform dirty whitish-yellow, the lines less distinct but the piliferous spots proportionately larger. Head quite variable in depth of shade.

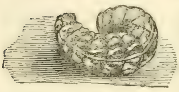
Perfect Insect.—Average length 0.70; alar expanse 1.50. General color of fore wings very light pearly bluish-gray, with a perceptible deepening posteriorly. Quite variable, sometimes of a more decided blue, at others inclining to buff as in *Leucania unipunctata*, Haw. Markings, when distinct, as in Plate 1, Figures 5 and 6. With the exception of the reniform spot and subterminal line, however, they are usually distinct only on costa, being either indistinct or entirely obsolete on the rest of the wing. The subterminal line is light, with a more or less dark diffuse shade each side, which, in some instances, forms into sagittate spots. A black stain at the lower part of reniform spot forms a most distinctive character. Hind wings very pale and lacking the bluish cast of fore wings; lunule distinct, and a dark shade, enclosing a lighter mark, as in *Heliothis*, along posterior margin. Eyes dark; head and thorax same as fore wings; abdomen same as hind wings. The whole under surface the same as hind wings above, the lunules and arcuated bands faintly traced, the fore wings having a darker shade in the middle.

Described from 30 bred specimens.

THE W-MARKED CUT-WORM.—Pl. 1, Fig. 13.
(Larva of the Clandestine Owlet moth, *Noctua clandestina*, Harris.)

Another cut-worm which has this same habit of climbing trees, I have named the W-marked cut-worm, on account of the characteristic markings resembling this letter, which it has on its back. Its general color is ash-gray, inclining on the back and upper sides to dirty yellow, and the annexed Figure 27 gives a correct view of it. This species, so far as I have observed, though it has been caught in the act of eating apple buds, is but seldom found very high up on trees, but seems to prefer to attack low bushes, such as currants, on which I have often found it. It occurs abundantly on a species of wild endive (probably *Cichorium sativa*), under the broad leaves of which it frequently nestles during the day, without entering into the ground. Harris quotes a communication from Dr. F. E. Melsheimer, of Dover, Pa., in which this same worm is said to attack young corn, and to feed indiscriminately on all succulent plants, such as early sown buckwheat, young pumpkin-plants, young beans, cabbage plants, and many other field and garden vegetables. Mr. Glover, of the Department of Agriculture, has also found it to attack wheat, and I have found it quite injurious to young cabbages. In feeding, it frequently drags its food under stones and other places of concealment. The young worms are of a more decided gray than the older ones, with the black W-shaped marks less distinct, and subsist, for the most part, on grasses.

[Fig. 27.]



The moth produced from this worm is illustrated at Plate 1, Figure 13. It appears during the latter part of June, and is, consequently, one of our earliest. It is of a dark ash-gray color, with the wavy bands but faintly traced. The two ordinary spots are small, narrow, and usually connected by a fine black line. The hind wings are dirty brownish-white, somewhat darker behind. It may be popularly known as the Clandestine Owlet moth, and was named *Noctua clandestina*, by Harris, though it might be placed with more propriety in the genus *Graphiphora*.

NOCTUA CLANDESTINA, Harris.—*Larva*—Length, when full grown, 1.15 of an inch. General color ash-gray, inclining on the back and upper sides to dirty yellow. Finely speckled all over with black and brown spots. Along the dorsum there is a fine line of a lighter color, shaded on each side, at the ring joints with a darker color. Sub-dorsal line light sulphur-yellow, with a band of dirty brownish-yellow underneath. Along the stigmatal region is a wavy line of a dark shade, with flesh-colored markings underneath it; but the distinguishing feature is a row of black velvety marks along each side of the back, on all but the thoracic segments, and bearing a general resemblance, looking from anus to head, to the letter W. Ventral region greenish-gray; prolegs of same color; thoracic legs brown-black. Head black, with a white line in front resembling an inverted Y, and white at sides. The thoracic segments frequently have a greenish hue.

Chrysalis.—Of the normal form and color, with but one rather long thorn at extremity.

THE GREASY CUT-WORM.—Pl. 1, Figs. 8, 9 and 10.
(Larva of the Lance Rustic, *Agrotis telifera*, Harris.)

In the *Prairie Farmer* for June 22, 1867, I described a large cut-worm under the name of the "Black cut-worm." I have since ascertained that it is quite variable in its coloration, some specimens being lighter, and the markings much more distinct than in others, and have therefore concluded to give it the above appellation. This worm is usually of a deep leaden-brown inclining to black, though some specimens are of a greasy glaucous color, with a dark flesh-colored back. It is always more or less distinctly marked as in Figure 9, of Plate 1, while the head, when retracted within the first segment, presents the appearance of Figure 10 on the same plate, this figure being enlarged beyond the natural size. It is probably the most common cut-worm in the country, for the moth is frequently caught in our rooms in all parts of the United States. Though it has not, so far as I am aware, the climbing habit of the preceding species, it has a most emphatic and pernicious *cutting* habit.

Mr. Jordan, of the St. Louis nursery, had transplanted a great number of tomato plants last spring, but lost well-nigh every one of them by this pernicious worm. It cut off large plants that were over six inches in height, generally at about an inch above ground, and thus effectually destroyed them. After severing one plant, the same worm would travel to others, and thus in a single night, from three to four plants would be ruined by a single individual. Along the Clayton road, to the west of St. Louis, most of the corn had to be replanted on account of its attacks. On the 22d of May I examined several fields, and was surprised to find these worms present at almost every hill, most of them being two-thirds grown. The land is clayey, and was at that time quite hard, and each worm had a smooth burrow in which it lay hidden, and to the bottom of which it could generally be traced. I subsequently learned that a large tobacco field belonging to Mr. F. R. Allen, of Allenton, had been entirely ruined soon after it was planted, by this same worm, and I found it in my own garden cutting off cypress vines. Indeed, nothing seems to come amiss to its voracious appetite, for in confinement it devoured with equal relish, apple and grape leaves.

This species comes to its growth in this latitude by the end of May, though the moth does not make its appearance till the month of July.

The moth is known as the Lance Rustic (*Agrotis telifera*, Harris), and is represented in the annexed Figure 28, and still more correctly at Plate 1, Figure 8. The upper wings are light-brown shaded with dark-brown, and the under wings are pearly white, with a gray shade around the edges; but the characteristic feature, from which it takes its name, is a dark-brown lance-shaped mark running outwardly from the kidney-spot.

[Fig. 28.]

AGROTIS TELIFERA, Harris—*Larva*—(Pl. 1, Fig. 9)—Length 1.50@1.60 inches when crawling. General color above, dull dark leaden-brown. A faint trace of a dirty yellow-white line along dorsum. Subdorsal line more distinct, and between it and stigmata two other indistinct pale lines. Eight black shiny piliferous spots on each segment; two near subdorsal line, the smaller a little above anteriorly; the larger just below it, a little back of the middle of the segment, with the line appearing especially light above it. The other two are placed each side of stigmata, the one anteriorly a little above, the other just behind, in the same line with them, and having a white shade above it. Head light brown, with a dark brown spot each side and dark brown above, leaving the inverted Y mark in the middle, light brown, and having much the appearance of a goblet, as one looks from tail to head. Cervical shield dark brown, except a stripe above and each side. Sparse short white bristles laterally and posteriorly. Venter and pro-legs of a glaucous glassy color. Thoracic legs light brown.

It varies considerably in depth of shading, and some of the lighter specimens have the lateral stripes quite distinct, and the dorsum is frequently of a dull carneous with a darker shade, divided by a fine line of a lighter color, along the middle. There is frequently a third piliferous spot near the stigmata.

Chrysalis.—Average length 0.54 of an inch, very pale shiny yellowish-brown, with two large dark brown eye-spots. Stigmata and anterior edge of four largest abdominal segments on the back, also dark brown and shagreened. Two minute thorns at extremity.

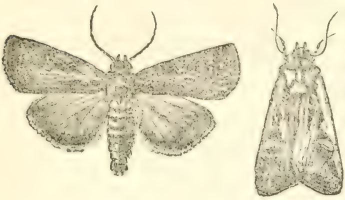
Imago.—As Harris's description, as given in his "Injurious Insects," is not very complete, I subjoin a more detailed one: Average expanse 1.60 inches. Color of fore-wings brownish-gray, verging into a very dark brown, with a bluish tint at the costa, for nearly one-third the width of the wing. Middle area somewhat darker than basal and limbal, the latter being especially light at the apex, and between transverse posterior and subterminal lines; having distinct spots on the nerves, and two distinct sagittate marks. Ordinary spots dark, with a very fine dark brown annulation, especially distinct around the dentiform. Reniform spot of normal shape. Orbicular nearly oval, and generally elongated into a point posteriorly. Distinguishing feature a dark brown lance-shaped mark, running from posterior portion of reniform spot. Transverse anterior geminate, dark. T. posterior geminate, dark, projected and arcuated above. Subterminal line light, irregular and festooned. Median band distinct. Subterminal space dark, especially where broadest, at nerves 5, 6 and 7. Margins dark brown, with a lighter inward, angular rim between each nerve. Costa with usual spots. Fringes light, with a central line, the inner half having dark square spots on the nerves. Hind wings pearly white, semi-transparent, margined behind and veined with dusky gray. Fringes even whiter, with a faint darker line. Under side of fore wings pearly-gray; hind wings concolorous, but with a broad band of speckled gray on the anterior margin. Legs dark, with light spots at joints. Head often rust-brown. Antennæ brownish. Prothorax very clearly defined, and of a rich dark brown at margins. Thorax and body light lilaceous-gray, the tegulæ being rimmed with flesh color.

THE WESTERN STRIPED CUT-WORM.

(Larva of the Gothic Dart, *Agrotis subgothica*, Haworth).

Dr. Fitch, in his Second Report, on noxious insects of the State of New York, describes a cut-worm by the name of the "Striped cut-worm," (p. 313). In his 9th Report, (pp. 245–8), this worm was very fully re-described, together with the moth which it produces. This worm seems to have done great injury to the corn crop in the East, and the moth is a variety of the Corn Rustic (*Agrotis nigricans*, Linn,) which Dr. Fitch named *maizi*. It will be referred to on page 87. From worms, found in an orchard, and answering entirely to that description. I have bred numerous specimens of one of our most common owlet moths, namely, the Gothic Dart (*Agrotis subgothica*, Haworth.) As the worms are so similar in appearance, I have called the one under consideration, the "Western Striped Cut-worm," as no other name would better characterize it, though it is evidently as common in the East as it is in the West. Its general appearance is not greatly unlike that of the "Greasy Cut-worm" already described, but its average size is but 1¼ inches. The ground color is dirty white or ash-gray and it has three broad dark lines, and two light narrow ones along the sides, and a light one, edged on each side with a dark one, along the middle of the back. This species remains longer in the ground than any of the others, and the moth does not appear till August and September. The moth is represented at Figure 29, *a*, with the wings expanded, and at *b* with the wings closed. Its markings are so conspicuous and characteristic that it suffices to say that the light parts are of grayish flesh-color, and the dark parts of a deep brown. It was first described in the year 1810 by Mr. Haworth, and is supposed to be an English insect; but as it is quite rare in England, and very common in this country, Dr. Fitch concludes, and I think rightly, that it is an American insect, the eggs or larvæ of which have accidentally been carried to England.

[Fig. 29.]



a *b*

AGROTIS SUBGOTHICA, HAW.—*Larva.*—Length 1.25 inches. Ground color dirty white or ash-gray, inclining in some instances to yellowish. A whitish dorsal line edged on each side with a dark one. Three lateral dark broader stripes—the lower one broadest of all—separated by two pale ones. Quite often an indistinct glaucous white stripe under the lower broad dark one. Piliferous spots of good size. Head shiny black, or in some individuals finely speckled with white, especially at the sides; with the usual forked white line like an inverted Y. Cervical shield, or upper portion of the first segment, of the same shiny color as the head, with a white stripe in the middle, contiguous to that on the head, and another each side. Venter dull white. Legs the same, varied with smoky brown.

THE DINGY CUT-WORM—Pl. 1, Fig. 11.

(Larva of the Dart-bearing Rustic, *Agrotis jaculifera.*)

We have, in the West, another cut-worm, resembling the preceding species in almost every particular, the following being the only permanent differences: 1st, It never attains quite so large a size, 2d, it is generally darker and more dingy, and the longitudinal lines are consequently less distinct; 3d, it is generally of a more decided dull pale buff color on the back.

On the 27th of last June, I received several of these cut-worms from Mr. Horace Starkey, of Rockford, Illinois, with a statement that they were proving quite destructive in the gardens of that vicinity, but without specifying what particular plants they attacked. They entered the ground soon after being received, and by the 7th of July, had all changed to chrysalids. The chrysalis differs from most of the others, in being of a very light honey-yellow, shaded with brown, with the eyes dark brown, and two sub quadrate spots of the same color on the wing-sheaths, just above the antennæ. It measures 0.65 of an inch in length. The moths began to issue on the 2d of September, and proved to be a species very closely allied to the preceding. Indeed the markings on the wings are almost exactly the same; but it is a smaller species, seldom expanding more than 1.25 inches and differs materially upon a strict comparison, and especially in the ground color being lighter and more silvery. It is faithfully represented at Plate 1, Figure 11. This species, as I am kindly informed by Mr. Cresson, is marked *Agrotis jaculifera* in the collection of the American Entomological Society, but without authorship; and as the name seems appropriate I have retained it.

Thus we have in this country, at least three species of cut-worms, which differ no more from one another in general appearance, than do individuals of the same species; and yet they all produce distinct moths, though it is worthy of remark that the moths produced from worms so resembling each other, viz: *Agrotis nigricans*, var *maizi*, *A. subgothica* and *A jaculifera*; have, all three of them, the space between and behind the two ordinary spots on the front wings of a dark brown color. It is possible that each of these species may have a different habit, but time, and further investigation will alone determine the point.

AGROTIS JACULIFERA—*Larva*—Length one inch. Similarly marked to that of *Agrotis subgothica*, with the colors darker and more dingy, the longitudinal lines less conspicuous, and the dorsum of a more decided pale buff color.

Chrysalis—Length 0.65–0.70. Color honey-yellow with dull brown shadings, and dark-brown eyes, but characterized especially by two subquadrate dark spots on the wing-sheaths just above antennæ.

Perfect insect—Much resembling *A, subgothica*, Haw., being marked as at Plate 1, Figure 11. It differs from that species in the following respects: The average expanse is but 1.30. The whole ground-color is colder (to use the language of the artist), i. e., of a whiter gray, with less of the buff color. The costa is darker, and the light costal band narrower; the posterior median nerve is almost white and very distinct to the lower part of the reniform spot; nerves 3, 4 and 5 are well relieved by light margins; the streak running between nerves 2 and 3 is very distinct and less diffuse; the terminal space is darker, and the inner margin only broken by nerves 4 and 5; there are no sagittate spots, while the posterior margin is very clearly defined by a black line bounded outwardly by a light one.

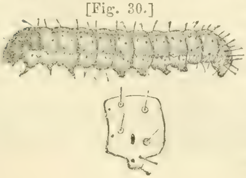
Described from three bred specimens.

THE GLASSY CUT-WORM.

(Larva of the Devastating Dart, *Agrotis devastator*, Brace.)

In the year 1819, in a short article upon the cut-worm, published in the first volume of Silliman's Journal, p. 157, Mr. Brace, of Litchfield, Connecticut, gave an account of this moth, which he bred from pupæ that were found a few inches under the ground, in a cabbage patch. He did not describe the worm which produced the pupæ, as he evidently supposed there was but one kind of cut-worm in existence. Consequently, up to the present day the larva of this common Devastating Dart moth has been unknown. It was my good fortune to breed this moth from the larva state. The cut-worm from which it

[Fig. 30.]



was produced, was found on the 12th of May under a wild endive plant, upon the leaves of which it had evidently been feeding. It was but half grown, and, being placed in a jar half filled with earth, that contained growing grass, it burrowed into the earth and after once casting its skin, fed entirely on the roots of the grass, though other food was thrown into the jar. On the 7th of June it measured 1.80 inches when crawling, and on the 19th of the same month had changed to a chrysalis from which the moth emerged on the 7th of July. The worm is represented at Figure 30, and may at once be distinguished from all others of its tribe, that are known, by its translucent glassy green body, in contrast with a very distinct hard, polished, dark-brown shield on the first segment, and a bright venetian-red head. The usual spots on the body are quite distinct, and placed in the positions given at the lower outline of Figure 30, which represents the side of one of the middle segments.

The moth bears a close general resemblance to the Cochran Rustic already described, the ground color being the same. It differs in its larger size; in the wavy transverse lines being more equidistant; in the spots in the shape of arrow heads, which emanate from the inside of the last or outer line, being darker and more distinct; and in the outer edge of the large kidney-shaped spot being almost always quite white. Entomologically, it differs still more essentially, for though named *Agrotis devastator*, it seems to belong to the genus *Mamestra*. Here we have the converse of the facts given, in speaking of the Dingy cut-worm, for, closely as the Cochran Rustic and this Devastating Dart moth resembles each other, their larvæ are very dissimilar.

AGROTIS (MAMESTRA) DEVASTATOR, Brace—*Larva.*—Length 1.80. Color translucent glassy green, with a tinge of blue. Usually, a very deep bluish dorsal line. Four distinct piliferous spots on each segment, each with a slight annulation. Two other minute simple spots, without hairs on the anterior edge of the segment (see Fig. 30,). Head, bright Venetian-red, with black jaws, and a small black spot each side. Cervical shield, very distinct, hard, polished and of a dark brown. Caudal plate, less defined and more dusky. The body is lighter posteriorly than anteriorly and the dorsal line is most distinct along the middle segments.

Chrysalis—Quite dark mahogany brown, with the body somewhat more attenuated than is usual, and with two distinct slightly curved thorns at extremity with several other stiff bristles around them.

THE SPECKLED CUT-WORM—Pl. 1, Figs. 14, 15, 16 and 17.
(Larva of the Subjoined Hadena, *Hadena subjuncta*, Gr. & Rob.)

At two different times, I have found in a truck garden hiding in the ground, under cabbage plants, near St. Louis, a cut worm which may be known by the above name. On one occasion, I also received the same worm from my friend, Mr. A. Bolter, of Chicago, who found it in Wisconsin. It is at once distinguished from all others that are known by several characteristics, but more especially by being speckled as with pepper and salt, when viewed with a pocket lens, the ground color being flesh-gray, with a tinge of rust color in the middle of each segment. The head is marked as in Figure 15, each segment on the back as in Figure 16, and the extremity as in Figure 17 of Plate 1—these figures being enlarged the better to show the markings.

Those which I bred, fed voraciously on cabbage leaves during the night and lay concealed and motionless during the day. Before changing to chrysalids, they became of a uniform pale dirty yellow, with the markings almost entirely obliterated. The chrysalis is of the usual form and the moths appeared between the 2d and 8th of August. The kind of moth that was produced from these worms is faithfully represented at Plate 1, Figure 14, the front wings being marked as in the figure, with grayish-brown and black, and having a dull flesh-colored shade. It differs essentially from all those that I have hitherto described, and belongs to a different genus (*Hadena*). It was named *Hadena subjuncta* by Guénée, in his MS. and this name has been retained by Messrs. Grote & Robinson, in their description of it published in the Transactions of the American Entomological Society, Volume II, pp. 198–9, which will be found below.

HADENA SUBJUNCTA, Gr. & Rob.—*Larva.*—Average length 1.60 inches. Color carneous-gray, inclining to ferruginous in the middle of each segment. Minutely speckled as with pepper and salt. A lateral stigmatal stripe, somewhat lighter than the rest of the body. An interrupted dorsal and subdorsal white line, these lines being quite distinct on the posterior half and indistinct on the anterior half of each segment. Two distinct spots anteriorly on the dorsum of each segment; the other spots obsolete. Head light shiny brown, with two outwardly diverging darker marks. Segment 1, with the three longitudinal white lines and a white anterior edge, shaded on the inside with dark brown. Anal segment with a white transverse line, somewhat in the shape of a drawn-out W, and with a deep shade above it. Venter glaucous. Legs of the same color.

Chrysalis.—Of a deep brown color, rather short and thick, and with two bristles at extremity.

Imago—(Pl. 1, fig. 14). Length 0.65; expanse 1.50. ♂ ♀.—Antennæ simple, finely and shortly ciliate beneath. Carneous brown. Head with a dark frontal line. Prothoracic pieces with a very distinct and deep brown line. Abdomen crested above at base, with a spreading anal tuft in the male. Fore wings, above, blackish brown shaded with carneous. A longitudinal deep brown basal ray, shaded inferiorly, extending outwardly and narrowly to the transverse anterior line. Above this ray, the base is tinged with carneous, and the basal line is indicated by a dark geminate costal streak. Transverse anterior line geminate, the outer line the darker, roundedly and evenly interspaceally waved, nearly prependicular. Ordinary spots very large, distinctly limited. The median space is wide superiorly, but is constricted below the median nervure; a longitudinal deep brown streak runs along the submedian fold and connects the two median lines at their point of greatest contiguity. This streak becomes the lower margin of the claviform spot which abutts from the transverse anterior line, and whose upper margin is seen in a very distinct deep brown line running outwardly and downwardly obliquely from the median nervure. Above the claviform is the large obicular, pale, with a distinct annulus. The reniform is wide, of the ordinary shape, with an indistinct central shade and the distinct annulus is often obsolete outwardly. Beyond the reniform, the wing is shaded with carneous to the subterminal line, this shade spreading inferiorly. A diffuse and faint blackish median shade runs from the costa downward between the ordinary spots and is discontinued below median nervure. The transverse posterior line is incepted above the reniform, runs outwardly straightly along the costal region, thence downwardly over the nervules, bending inwardly beneath the reniform spot. It is geminate, faint, the lines enclosing a paler space and interspaceally lunulate. Subterminal line pale, preceded by a dark shade, forming the usual M-shaped mark at the middle, the points of the M attaining the external margin. The dark shading is sometimes tinged with olivaceous before the internal angle as is the inferior shading of the longitudinal streak connecting the median lines. The terminal space is blackish brown and black interspaceal marks precede the terminal line. The fringes are uneven; the external margin of the wing retires inwardly before internal angle.

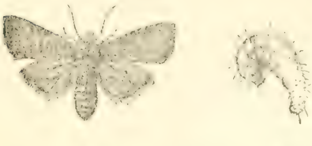
Hind wings smoky blackish, paler towards the base, without discernable discal mark or lines. Under surface pale. The wings terminally and along costal edges are covered with powdery squamation with intermixed dark scales bringing the nervules into relief. The fore wings show three ante-apical white dots and the white subterminal shade line emanates from a fourth and larger dot just before the apex, these latter at times hardly discernable. Faint discal dots; sometimes traces of dark median lines can be seen on both wings.

THE SMALL WHITE BRISTLY CUT-WORM.

(Larva of the Figure 8 Minor, *Celæna renigera*, Stephens).

During the month of August in North Illinois, a small dirty-white cut-worm may frequently be found in flower gardens, where it doubtless feeds for the most part on the roots of various flowers. This worm is represented at Figure 31 *b*. It never gets to be more than $\frac{3}{4}$ of an inch in length, and is covered with distinct, stiff yellow bristles, and may be popularly known by the above name. During the fore part of August it descends deeper into the ground, and soon changes to a very bright shiny, mahogany brown chrysalis, from which in about three weeks afterwards, the moth emerges.

[Fig. 31.]



a b

This moth is represented (as well as a wood cut can represent it) at Figure 31 *a*. It is quite prettily marked, the fore-wings being brown, variegated with lilac-gray and moss-green, with a deep brown spot about the middle and a silvery annulation around the kidney-shaped spot. It is the *Celæna renigera* of Stephens of which *C. herbimacula*, Guénée is a synonym, and as it should have a popular name, it may be called the "Figure 8 Minor," in allusion to the silvery edge of the kidney-spot which almost always reminds one of the figure 8. In the genus *Celæna* the wings are entire, broad and rounded, and there is a conspicuous tuft on the crown of the head. The species may at once be distinguished from those of *Agrotis* and *Hadena* by their smaller size and more rounded appearance.

CELÆNA RENIGERA, Stephens.—*Larva.*—Length 0.75 of an inch.—Color dusky salmon-yellow, the dusky dirty appearance, caused by innumerable dark specks all over it. Largest at the four middle segments and tapering thence each way. A dark lateral stripe, distinct on the middle segments, indistinct at both ends. Distinguishing feature, very visible stiff yellowish bristles, proceeding from the usual spots which are small. A dorsal line is indicated under the glass by two indistinct thin lines at the joints of the segments.

Chrysalis.—Length 0.56 of an inch; concise; of a bright polished mahogany brown, with dark eyes and very slightly punctured on the anterior portion of the abdominal segments.

Imago.—Expanse 1.10 inches. Fore wings brownish-gray, with a more or less determined carneous or lilaceous hue. Orbicular spot sub-obsolete; sometimes entirely obsolete. Reniform spot of normal shape, moss-green, with a snow-white annulation, indistinct above; broad and distinct below. Ordinary lines lighter. Basal half-line distinct only on costa, and below posterior median nerve. Transverse anterior single, obliquing but slightly, and bordered posteriorly with a very thin broken darker line; it is moss-green in the middle, and there is a green shade running from it to the basal half-line, dividing the sub-basal space. Opposite this green in the median space, is a dark subquadrate almost black spot, and between the stigma the wings are also quite dark. Transverse posterior single, posteriorly oblique a little more than $\frac{1}{3}$ of breadth of wing, then parallel with posterior margin, forming at the second nerve a roundish spot which extends to the anal angle, and is dark below and moss-green above. Subterminal line usually very indistinct—merely indicated by a few dots. A median arcuated band is perceptible, being broader and darker between the stigma and interrupted in the middle by lower portion of reniform spot. A minute light spot on each vein at posterior margin. Costa with a light spot at terminus of sub-basal line, of transverse anterior, and above reniform spots—dark each side of these and at terminus of median band; concolorous with wing at subterminal space, having four very minute light spots, one at ends of subterminal and transverse posterior lines, and two between them. Fringes concolorous with the wing, having a very fine darker edge.

Hind wings carneous-gray at base and interiorly—darker anteriorly and posteriorly and especially at posterior margin. Nerves and lunule rather dark. Fringes same color as interior of wing, with a darker central line.

Under surface of fore wings brownish-gray, the fringes and transverse posterior darker and the spots faintly marked at costa. Under surface of hind wings of same color above, lighter below, with the lunule dark and the arcuated band distinct.

Legs dark-gray with light spots at joints; palpi same color. Head, prothorax and thorax not quite so purplish as wings. Prothorax with a light margin at junction of wings—the tegulæ also with a light spot. Body same color as hind wings above, darker below. Feelers same.

OTHER CUT-WORMS.

Besides the ten distinct cut-worms, whose transformations I have just recorded, there are two others, which Dr. Fitch has described in all their stages. The one is the "STRIPED" or "CORN CUT WORM" as he calls it, which proves very injurious to corn, by cutting it off about an inch *above* ground. This worm produces a dusky-gray moth (*Agrotis nigricans*, Linn.—var. *maizi*), which is distinguished principally by two coal black spots, one nearly square, placed outside of the centre of the fore wing, and the other nearly triangular, a little forward of it, a roundish nearly white spot separating them. The other which Dr. Fitch has called the "YELLOW-HEADED CUT-WORM," is of a shining livid color, with a yellowish or chestnut-colored head and a horny spot of the same color on the top of the first and last rings. It is a large species and produces the Amputating Brocade moth (*Hadena amputatrix*, Fitch), which is figured on page 450, of Harris' work. This moth is distinguished by its Spanish-brown upper wings, marked with a large pale kidney-shaped spot, and a broad wavy blue-gray band near the end. The worm was found by Dr. Fitch to be even more injurious to corn than the striped species, since it severs the plant *below* ground; while it also combines the habit of climbing trees during the night, according to Harris.

Thus, we are now acquainted with the natural history of just one dozen of these cut-worms, while there is fully another dozen whose habits and history yet remain to be studied. Of one of these, especial- soon to give the complete history. Meanwhile, I will give a brief account of the worm itself, which may be known as

THE WHEAT CUT-WORM.

On the 10th of October, 1868, I received from Mr. F. R. Allen, of Allenton, Missouri, the following communication:

"Enclosed I send you some specimens of a worm that seems to be preying upon the recently sown wheat. My neighbor, Mr. George W. Moore, informed me a day or two ago, that a worm was eating all his wheat that he had lately sown in oats ground. I went to see what it was yesterday, and as I am not entomologist enough to tell, I refer them to you. Mr. Moore has learned within a day or two, that this same insect is now generally preying on the wheat in Franklin county, that is sown on oats stubble. What is remarkable they do not yet trouble the wheat in the same field sown on wheat stubble. Nor do they seem to feed on the volunteer oats in the same field, but entirely destroy the young wheat."

Subsequently, upon visiting Allenton, Eureka, and other places in St. Louis county, I ascertained from L. D. Votaw and others, that this worm had been known to attack wheat in the fall for many years back. They come to their growth the latter part of October, descend into the earth and pass the winter in the chrysalis state. The only manner in which I can account for their appearing only on that wheat which was sown on oats stubble, is by supposing that the scattering oats that were left after harvest had sprouted before the wheat, and had thus attracted the parent moths. On this supposition the worms had hatched and fed awhile, before the ground was ploughed, and planted to fall wheat, and this seems the more likely, since the worms were full-grown, almost as soon as the wheat appeared above ground. If this supposition be correct, the attacks of this worm can be effectually prevented by ploughing the land early and keeping the ground clear of all vegetation until the wheat is planted. No other rational explanation can be given, for I found by experiment that they would devour with equal relish the young plants of both oats, wheat, and a variety of grasses.

In the *Canada Farmer* for April 15, 1867, an account was given of the ravages of "cut-worms" on Spring wheat, in the county of Huron. Judging from the account however, the worm referred to, was the common "White grub;" but if it be the same as that spoken of above, the fact can be ascertained by the description which I subjoin herewith.

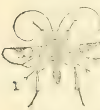
THE WHEAT CUT-WORM.—A dark pitchy black cut-worm, the characteristic mark being, a very distinct pale buff or flesh-colored stigmatal band. Dorsum generally of a brownish shade, the dorsal line of the same color, with a more or less distinct dingy shade each side of it. The subdorsal region is always the darkest part of the worm, being of a pitchy brown; but edged above, at junction of dorsum, with a fine light buff-colored line, and generally variegated in the middle, with very minute light colored irrorations. Eight sealing-wax-like black elevated piliferous spots on each segment, those on dorsum usually having a white base outwardly. Greatest width at segments 10 and 11, the spots upon them being also the largest. Head, deep polished brown, with the usual inverted Y-shaped white mark, and some white spots at sides; also with white lips, and perfectly white palpi. Cervical shield, of same color as dorsum, but polished, and with the dorsal and sub-dorsal white lines quite distinct upon it. Caudal plate with a bright cream-colored longitudinal dash (generally constricted in the middle) between two black spots. Venter and legs glassy glaucous. The young worm is almost uniformly pitchy black, with the light stigmatal band always visible however. Indeed this band is always constant no matter how much the worms vary in depth of ground-color.

There are various other naked caterpillars which are frequently found upon the ground near vegetation of various kinds. Thus during the months of July and August, a species with the back of each segment very characteristically marked as represented at Plate 1, Figure 12, may often be found. It seems to feed on a variety of herbs, and produces a prettily variegated moth known as *Prodenia commelinæ*, Guénée; but though this and other species may have the cutting habit, they have never attracted notice so far, and I shall pass them over and proceed at once to suggest the proper preventives and

REMEDIES AGAINST CUT WORMS.

NATURAL REMEDIES.—These cut-worms, like all other vegetable-feeding insects, have numerous insect enemies which are continually on the alert for them, and materially assist us in keeping them in due bounds. Of those that are parasitic internally may be mentioned the minute four-winged flies belonging to the genus *Microgaster*. One of these which is parasitic on the Army-worm (the *M. militaris* of Walsh) is represented at Figure 32, and it bears a strong resemblance to an undescribed species which I have often bred from a cut-worm, described in the *Prairie Farmer* as the "Pale cut-worm." The female fly punctures the tender skin of the worm and deposits great numbers of eggs in the body. These eggs produce maggots which live upon the fatty parts of the worm, and slowly but surely produce the death of their victim. When full grown they pierce the skin of the worm and spin their white silken cocoons, in company, on his body, and in due time issue forth as flies.

[Fig. 32.]



There is also a large yellowish-brown four-winged Ichneumon fly (the *Paniscus geminatus* of Say), which I have bred from cut worms. The parent fly deposits a single egg within the body of a worm, but the maggot hatching from this egg does not cause the worm to die, till after the latter has entered the earth to become a chrysalis. At this point the worm suddenly succumbs and the maggot spins a tough, black, smooth cocoon, and where we expected to see a moth rise to day-light, we behold in time this Ichneumon fly.

Among the cannibals, that bodily devour these worms, may be mentioned the Spined Soldier-bug, already referred to on page 77, note, and whose likeness I produce at Figure 33. This fellow is such a thorough cannibal, and so serviceable to man, that his portrait cannot be too well graven on the mind. It is not unlikely, also, that most of the ground beetles that are figured in a future chapter on the 10-lined Potato beetle, prey upon cut-worms; and the Homely Geopinus referred to in the note on page 77 has been found to do so, but by far the most efficient insect in slaying these worms is the larva of the Fiery Ground beetle (*Calosoma calidum*, Fabr.), which I represent at Figure 34 *a*, by the side of its parent Figure 34 *b*. This larva has very appropriately been called the Cut-worm lion, by Dr. Shimer of Mt. Carroll, Illinois, who gives the following account of its mode of transformation to the perfect beetle: "The fat, full grown larva of *Calosoma calidum* chooses a hard piece of ground, as a wagon road in the field, where it bores into to pass the pupa state. I have seen them many hours in boring a few inches. These

[Fig. 33.]

[Fig. 34.]

fierce insects often wage terrible battles when they encounter each other, and they will eat each other as readily as cut-worms, as I found whenever I put more than one of them into my collecting box. He that would breed these insects to the perfect state, must pack the dirt in his breeding box as hard as a wagon road, or he will fail, as I always did before I saw their operations in the field. In using moderately compact earth, the larva digs it over and over, endeavoring to find a suitably dense place, works up the dirt into balls, until its feet are clogged up with earth and juices from its mouth, and it sinks exhausted and dies. In a few days after it enters the ground, the beautiful spotted, perfect beetle appears, and, strangely, the smell of the beetle is peculiar and entirely different from the larva."

This Cut-worm lion has quite a formidable appearance, and is exceedingly agile. It is flattened, of a black color, with six legs upon the breast, and a pair of sharp hook-like jaws projecting in front of its head. It pursues the worms in their retreats under the ground, and seizes them wherever it comes in contact with them. Sometimes a young Cut-worm lion will seize a worm twice as large as itself, and will cling with bull dog tenacity to its prey, through all its throes, its writhings and twistings, till at last the worm succumbs, exhausted, and the victor bites two or three holes through its skin and proceeds to suck out its juices.

Some kinds of spiders are also known to prey on cut-worms, and these unwisely unpopular little animals should always be cherished and protected. Poultry is also quite efficient in destroying them, and chickens are better than any other kind. I cannot too strongly urge their claims as cut-worm destroyers, than by giving the statement of Mr. Cochran, to-wit: that he believed he could not possibly have coped with the worms without the aid of a large brood of chickens which he procured for that purpose.

Artificial Remedies.—The climbing cut-worms are easily headed off by a little vigilance. From the orchard planted upon light, warm soils they can be driven away entirely by claying the ground about the trees; a wheelbarrow full is well nigh enough for each tree when spread around its base and as far as the limbs extend. This is the most thorough and lasting. A small strip of tin, three inches wide, carefully secured around the body of the tree, will effectually prevent their ascension; if the tin is old and rusty it will require to be a little wider. Each night, after the swelling of the bud, an hour or two after midnight a slight jar of the tree will bring every one on it down, when they can be caught in a spread sheet and destroyed. This will have to be followed up till the bud has unfolded into the leaf, after which there is no longer anything to be apprehended from the worm. The reasons why the clay is so efficient, are two-fold: 1st—The worms seem to have an instinctive dislike to crawling over it. 2nd—In dropping from the tree on to the hard surface they are frequently disabled, and whether disabled or not, they cannot immediately burrow into it as in sand, and they are all the more exposed to their numerous mid-night enemies which are ever watching for them.

For the common field cut-worms, I am convinced that there is no better remedy, as a rule, than hunting and killing them. It is generally believed that ashes and lime used about plants will keep off cut-worms, and I might fill pages with recorded experiments, going to prove the good effects of these substances. The experimenters generally forget, however, that there is a period in the life of these worms when they of themselves go down in the earth and disappear, and anything applied just before this happens is sure to be heralded forth as a perfect remedy. Experiments show, however, that when placed in a box with separate quantities of ashes, lime, salt and mold, they will burrow and hide in all of them, but especially in the ashes and mold. Soot seems to be more obnoxious to them, and, although I have not yet had an opportunity to give it a thorough test, I do not wish to discourage its trial. Fall plowing, to be efficacious, must be done very late in the fall, when the worms are numbed with cold, and then I think it is of doubtful utility further than it exposes them to the attacks of enemies, including birds.

In a case like that, communicated by Mr. Allen, it would pay to dig a narrow ditch around the part of the field infested, the outward side to be made smooth and slanting under; for these worms cannot crawl up a perpendicular bank of earth. On the same principle, many an one may be entrapped by making smooth holes with a stick around hills of corn or other plants, and on going over the same ground the next day, those that are thus entrapped can be crushed by the end of the same stick. In corn fields that have been subject to the attacks of cut-worms, it is well to plant so much seed as will enable them to glut their appetites without taking all the stalks in the hill, and in this light the following lines contain a deal of wisdom:

> "One for the black-bird and one for the crow,
> Two for the cut-worm and three to grow."

INSECTS INFESTING THE POTATO.

As the potato forms one of our leading articles of diet, and is universally cultivated, an accurate knowledge of the insects which attack it, is of the utmost importance. A very full account of them was given in the October and November numbers of the AMERICAN ENTOMOLOGIST, and since the editions of those two numbers are entirely exhausted, I cannot do better than to transfer it, for the most part, to the pages of this report, with such additions and alterations as I have since found necessary.

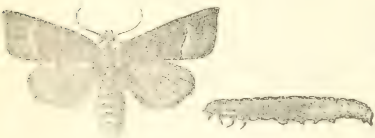
We often see paragraphs in the papers, stating that "THE Potato Bug" has been very abundant and destructive in such a month and at such and such a place. Accompanying these statements, remarks are frequently added, that "THE Potato Bug" is preyed upon by such and such insects, so that we may soon expect to see it swept from off the face of the earth; and that, even if this desirable event should not take place, "THE Potato Bug" may be checked and controlled by such and such remedies.

Do the worthy men, who indite these notable paragraphs, ever consider for one moment, that there are no less than eleven distinct species of bugs, preying upon the potato plant within the limits of the United States? That many of these eleven species are confined within certain geographical limits? That the habits and history of several of them differ as widely as those of a hog and a horse? That some attack the potato both in the larva state and in the perfect or winged state; others in the perfect or winged state alone; and others again in the larva state alone? That in the case of eight of these insects there is but one single brood every year, while of the remaining three there are every year from two to three broods, each of them generated by females belonging to the preceding brood? That nine of the eleven feed externally upon the leaves and tenderer stems of the potato, while two of them burrow, like a borer, exclusively in the larger stalks? Finally, that almost every one of these eleven species has its peculiar insect enemies; and that a mode of attack, which will prove very successful against one, two or three of them, will often turn out to be utterly worthless, when employed against the remainder?

THE STALK-BORER—*Gortyna nitela*, Guénée.

(Lepidoptera, Noctuidæ.)

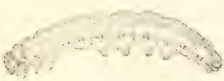
[Fig. 35.]



2

This larva (Fig. 35 2,) is of a livid hue when young, with light stripes along the body, as shown in the figure. When full grown it generally becomes lighter, with the longitudinal lines broader, and at this time it more frequently resembles Figure 36. It commonly burrows in large stalks of the potato; but is not peculiar to that plant, as it occurs also in the stalks of the tomato, and in those of the dahlia and aster and other garden flowers. I have likewise found it boring through the cob of growing Indian corn, and strangely confining itself to that portion of the ear: though it is likewise found occasionally in the stem of that plant. By way of compensation, it is particularly partial to the stem of the common cocklebur (*Xanthium strumarium*); and if it would only confine itself to such noxious weeds as this, it might be considered as a friend instead of an enemy. In 1868 it was more numerous than

[Fig. 36.]



usual, and was particularly abundant along the Iron Mountain and Pacific roads.

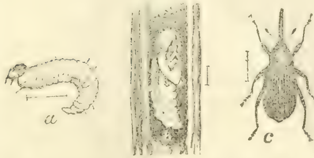
Never having found this worm earlier than June and July, nor obtained the moth from the very earliest matured ones, till the latter part of August and fore part of September, this insect must necessarily be single brooded, the egg requiring longer to hatch, and the larva longer to develop than of many other moths. Leaving the stalk in which they have burrowed the latter part of July, they descend a litte below the surface of the ground and in three days become chrysalids. These are of the normal form, with two fine bristles at the extremity of the body, usually closed so as to form a point, but readily opened V-shaped at the will of the insect, as with hundreds of others of the same class. I have had the moths issue as early as the 30th of August and as late as the 26th of September, and in one instance it emerged during a freezing night, being quite dull and numb at the time, thus showing beyond a doubt that the moths hybernate in a state of torpor, and then deposit their eggs, singly, on the plant destined for the worm, during the months of April and May. This moth (Fig, 35, 2) is of a mouse gray color with the fore wings finely sprinkled with Naples-yellow and having a very faint lilac-colored hue; but distinguished mainly by an arcuated pale line running across their outer third.

REMEDY—*Prevention.*—The careful florist, by an occasional close inspection of his plants about the beginning of July, may detect the point at which the borer entered, which is generally quite a distance from the ground, and can then cut him out without injury to the plant. As this is not feasible in a large potato field, care should be taken to prevent his attacks another year as far as it is possible to do so, by hunting for him wherever a vine is seen to suddenly wilt.

THE POTATO STALK-WEEVIL—*Baridius trinotatus*, Say.

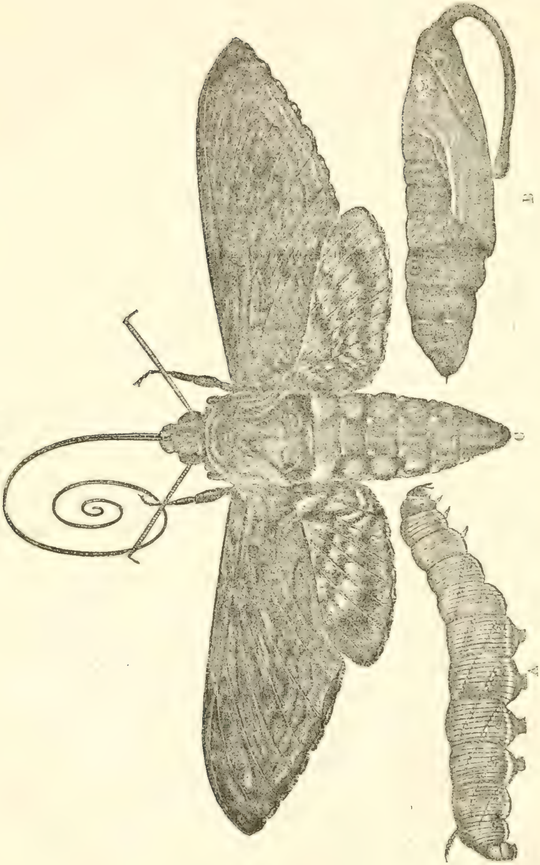
(Coleoptera, Curculionidæ.)

[Fig. 37.]



This insect is more particularly a Southern species, occurring abundantly in the Middle States, but, according to Dr. Harris, being totally unknown in New England. I found it in our own State last summer, equally as abundant as the preceding species. Indeed, some patches were utterly ruined by it, the vines appearing as if scalded. The beetle (Fig 37 *c*) is of a bluish or ash-gray color, distinguished, as its name implies, by having three shiny black impressed spots at the lower edge of the thorax. The female deposits a single egg in an oblong slit about one-eighth inch long, which she has previously formed with her beak in the stalk of the potato. The larva subsequently hatches out, and bores into the heart of the stalk, always, proceeding downwards towards the root. When

[Fig. 38.]



full grown, it is a little over one-fourth inch long (Fig. 37, *a*), and is a soft whitish, legless grub, with a scaly head. Hence it can always be readily distinguished from the larva of the Stalk-borer, which has invariably sixteen legs, no matter how small it may be. Unlike this last insect, it becomes a pupa (Fig. 37, *b*) within the potato stalk which it inhabits; and it comes out in the beetle state about the last of August or the beginning of September. The stalk inhabited by the larva almost always wilts and dies, and this wilting is first noticed in the latitude of St Louis, about the first of July, So far as is at present known it attacks no other plant but the potato, and the perfect beetle, like many other snout-beetles, must of course live through the winter to reproduce its species in the following spring.

REMEDY.—Same as with the foregoing species. Burn all the vines which wilt from its attacks—roots and all, for it almost always works below ground. The Stalk-borer must be *searched* for, if one will be sure of killing him as he *leaves* the stalk to transform; but as this Stalk-weevil transforms within the vine, one may be pretty sure of destroying it by burning the vines when they first wilt.

THE POTATO OR TOMATO-WORM—*Sphinx 5-maculata,* Haw.

(Lepidoptera, Sphingidæ.)

This well known insect, the larva of which is illustrated on the opposite page (Fig. 38, A), is usually called the Potato-worm, but it is far commoner on the closely allied tomato, the foliage of which it often clears off very completely in particular spots in a single night. Many persons are afraid to handle this worm, from an absurd idea that it has the power of stinging with the horn on its tail. But this is a vulgar error and the worm is totally incapable of doing any direct harm to man, either with the conspicuous horn on its tail, or with any hidden weapon that it may have concealed about its person. In fact, this dreadful looking horn is not peculiar to the Potato-worm, but is met with in almost all the larvæ of the large and beautiful group to which it belongs (*Sphinx* family.) It seems to have no special use, but, like the bunch of hair on the breast of the turkey cock, to be a mere ornamental appendage.

When full-fed, which is usually about the last of August, the Potato worm burrows under ground and shortly afterwards transforms into the pupa state (Fig. 38, B). The pupa is often dug up in the spring from ground where tomatoes or potatoes were grown in the preceding season; and most persons that meet with it suppose that the singular, jug-handled appendage at one end of it is its *tail.* In reality, however, it is the *tongue-case*, and contains the long pliable tongue which the future moth will employ in lapping up the nectar of the flowers, before which, in the dusky gloom of some warm, balmy summer's evening, it hangs for a few moments suspended in the air, like the glorified ghost of some departed botanist.

The moth itself (Fig. 38, C) was formerly confounded with the Tobacco-worm moth (*Sphinx Carolina*, Linnæus), which indeed it very closely resembles, having the same series of orange colored spots on each side of the abdomen. The gray and black markings, however, of the wings differ perceptibly in the two species; and in the Tobacco-worm moth there is always a more or less faint white spot or dot near the centre of the front wing, which is never met with in the other species. In Connecticut and other northern States where tobacco is grown, the Potato-worm often feeds upon the leaves of the tobacco plant, the true Tobacco-worm being unknown in those latitudes. In the more southerly States, on the other hand, and in Mexico and in the West Indies, the true Potato-worm is unknown, and it is the Tobacco-worm that the tobacco growers have to fight. While in the intermediate country both species may frequently be captured on the wing in the same garden and upon the same evening. In other words, the Potato-worm is a northern species, the Tobacco-worm a southern species; but on the confines of the two districts exclusively inhabited by each, they intermingle in varying proportions, according to the latitude.

REMEDIES.—This insect is so large and conspicuous that the most effectual mode of destroying it is by hand-picking. In destroying the worms in this manner care should be taken to leave alone all those specimens which one finds covered with little white oval cocoons, as these are the cocoons of little parasites* which materially assist us in its subjugation.

THE STRIPED BLISTER-BEETLE—*Lytta vittata*, Fabr.

(Coleoptera Meloïdæ.)

The three insects figured and described above infest the potato plant in the larva state only, the two first of them burrowing internally in the stalk or stem, the third feeding upon its leaves externally. Of these three the first and third are moths or scaly-winged insects (order *Lepidoptera*), so called because the wings of all the insects belonging to this large group are covered with minute variously-colored scales, which, on the slightest touch, rub off and rob the wing of all its brilliant coloring. The second of the three, as well as the next four foes of the potato, which I shall notice, are all of them beetles or shelly-winged insects (order *Coleoptera*), so called because what would normally be the front wing is transformed here into a more or less hard and shelly wing-case, which, instead of being used as an organ of flight, is employed merely to protect and cover the hind wings in repose. To look at any beetle, indeed, almost any inexperienced person would suppose that it has got no wings at all; but in reality nearly all beetles have full sized wings snugly folded up under their wing-cases, and, whenever they choose it, can fly with the greatest

* There are two distinct parasites which attack this worm, both species being very much of a size. One issues from the worm and spins a *smooth* white silken cocoon which it fastens by one end to the skin of the worm, and in due time produces a fly which Mr. Norton informs me is an undescribed species of *Blacus*, West. (*Braconides polymorphi*). The other species forms an immense mass of loose woolly cocoons and produces an apparently undescribed species of *Microgaster*.

ease. This is the case with the four following beetles which infest the potato. As these four species all agree with one another in living under ground and feeding upon various roots, during the larva state, and in emerging to attack the foliage of the potato, only when in the course of the summer they have passed into the perfect or beetle state; it will be quite unnecessary to repeat this statement under the head of each of the four. In fact, the four are so closely allied, that they all belong to the same family of beetles, the blister-beetles (*Lytta* family)—to which also the common imported Spanish-fly or blister-beetle of the druggist appertains—and all of them will raise just as good a blister as that does, and are equally poisonous when taken internally in large doses. In Missouri, these blister-beetles were more numerous and more injurious in 1868 than the dreaded Colorado Potato-beetle.

The Striped Blister-beetle (Fig. 39) is almost exclusively a southern species, occurring in particular years very abundantly on the potato vine in Central and Southern Illinois, and in our own State, though according to Dr. Harris, it is also occasionally found even in New England. In some specimens, the broad outer black stripe on the wing-cases is divided lengthways by a slender yellow line, so that instead of *two* there are *three* black stripes on each wing-case; and in the same field all the intermediate grades between the two varieties may be met with; thus proving that the four-striped individuals do not form a distinct species, as was formerly supposed by the European entomologist, Fabricius, but are mere varieties of the same species to which the six-striped individuals appertain.

[Fig. 39.]

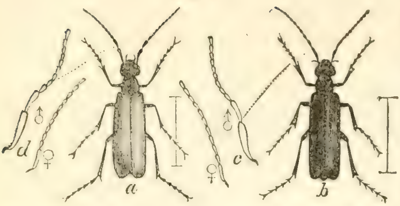
The late Samuel P. Boardman, of Lincoln, Illinois, discovered that this Striped Blister-beetle, like the Colorado beetle, eats all other potato tops in preference to Peach-blows. (See *N. Y. Sem. Tribune*, July 13, 1868.) This is certainly a new fact, so far as regards the former species, though it has long been ascertained to be true of the latter, but as I shall presently show, the Margined Blister-beetle has the same tastes.

THE ASH-GRAY BLISTER-BEETLE*—*Lytta cinerea*, Fabr.

This species (Fig. 40 *a*, male) is the one commonly found in the more northerly parts of the Northern States, where it usually takes the place of the Striped Blister-beetle figured above. It is of a uniform ash-gray color; but this color is given it by the presence upon

* In the male of this species, but not in the female, the first two joints of the antennæ are greatly elongated and dilated; which is also the case with the species next to be referred to. (Fig. 40 *d*, represents the male antennæ, above; that of female below.) Hence, in splitting up the extensive and unwieldy old genus (*Lytta*), these and certain allied species have been very properly placed in a genus by themselves (*Macrobasis*); while the Striped Blister-beetle and the Margined Blister-beetle, not possessing this peculiarity, are grouped together under a distinct genus (*Epicauta*). Practical men, however, who do not desire to trouble their heads with these niceties, will find it most convenient to class them all together under the old genus (*Lytta*); and this we have accordingly done.

[Fig. 40.]



its body of minute ash-gray scales or short hairs, and whenever these are rubbed off, which happens almost as readily as on the wings of a butterfly, the original black color of its hide appears. It attacks not only potato vines, but also honey-locusts, and especially the English or Windsor bean, and I found it quite abundant on the Early Snap bean at Hermann, last summer. It also attacks the foliage of the apple-tree, and likewise gnaws into the young fruit.

THE BLACK-RAT BLISTER-BEETLE—*Lytta murina*, Le Conte.

This species (Fig. 40 *b*, male) is sometimes found upon the potato in the month of July, and early in August. In 1867 it was found by Mr. D. W. Kauffman, to swarm on the potato vines near Des Moines, Iowa; but I have not yet met with it in Missouri.

THE BLACK BLISTER-BEETLE—*Lytta atrata*, Fabr.

This species is very similar in appearance to the Black-rat Blister-beetle; the latter being distinguishable from it only by having four raised lines placed lengthwise upon each wing-case and by the two first joints of the antennæ being greatly dilated and lengthened in the males as shown at Figure *c*. The Black Blister-beetle appears in August and September, and is very common on the flowers of the Golden-rod. I learned from several parties, while attending the October meeting of the Meramac Horticultural Society, at Eureka, that it had been quite numerous on the potatoes in that vicinity, and that they did much damage in some patches. The severe drouth of the summer had retarded the development of the tubers, so that this beetle attacked the vines before the latter were formed; but as a general rule, it makes its appearance too late in the season to do great damage.

THE MARGINED BLISTER-BEETLE*—*Lytta marginata*, Fabr.

[Fig. 41.]

This species (Fig. 41) may be at once recognized by its general black color, and the narrow ash-gray edging to its wing-cases. It usually feeds on certain wild plants; but I found it quite abundant on potatoes last summer, both in our own State and in Illinois. It appears not to attack the Peach Blow variety, for Mr. Wm. Brown, of Eureka. informs me that he had a patch of Quaker Russetts by the side of another patch of Peach Blows, and while the former were entirely eaten up by it, the latter were untouched.

* This is the name formerly given by almost all entomologists to this species; and a most appropriate one it is, in view of the remarkable ash-gray margin of its black wing-cases (*clytra*). But of late years it has been discovered, that, as long ago as the middle of the last century, and several

REMEDIES.—The same remedies will apply equally to all five of the Blister-beetles that have just been described. Let it be remembered that during the heat of the day, these beetles are ready with their wings and may be driven from the vines. Thus the most practical and efficient mode of destroying them, is to drive them into a windrow of hay or straw, and kill them by setting fire to it. As they all appear rather late in the season, I should recommend the planting of early varieties, which will be more likely to escape their attacks; and especially of the Peach Blow variety, the leaves of which seem to be more distasteful to them than those of any other variety.

THE THREE-LINED LEAF-BEETLE—*Lema trilineata*, Olivier.—(Coleoptera, Chrysomelidæ.)

[Fig. 42.]

The three first insects, described and figured above as infesting the potato-plant, attack it only in the larva state. The five next, namely the five Blister-beetles, attack it exclusively in the perfect state. The three that remain to be considered attack it both in the larva and in the perfect state, but go underground to pass into the pupa state, in which state—like all other Beetles, without exception—they are quiescent, and eat nothing at all.

The larva of the Three-lined Leaf-beetle may be distinguished from all other insects that prey upon the potato by its habit of covering itself with its own excrement. In Figure 42 *a*, this larva is shown in profile, both full and half grown, covered with the soft, greenish excrementitious matter which from time to time it discharges. Figure 42 *c*, gives a somewhat magnified view of the pupa; and Figure 42 *b*, shows the last few joints of the abdomen of the larva, magnified, and viewed, not in profile, but from above. The vent of the larva, as will be seen from this last figure, is situated on the upper surface of the last joint, so that its excrement naturally falls upon its back, and by successive discharges is pushed forward towards its head, till the whole

years before Fabricius named and described this insect as the "Margined Blister-Beetle" (*Lytta marginata*), it was named and described as the "Ash-gray Blister-beetle" (*Lytta cinerea*), by Foerster. Hence, in accordance with the inexorable "law of priority," the obedient scientific world has been called upon to adopt Foerster's name for this species; and as two species belonging to the same genus can not, of course, have the same specific name, the true Ash-gray Blister-beetle of Fabricius (*Lytta cinerea*), which is really ash-gray all over, has been re-christened by the name of "Fabricius' Blister-beetle" (*Lytta Fabricii.*) Positively, this continual chopping and changing in scientific nomenclature is getting to be an unbearable nuisance, and must be put a stop to. Otherwise one-half of the time of every entomologist, which might be much better occupied in studying out scientific *facts*, will be frittered away in studying out scientific *phrases*.

Many writers, in giving the scientific designation of an insect, neglect to add the name of the author who first described it. This practice often leads to error, uncertainty, and confusion, as the preceding example will at once show. If, for instance, we write simply "*Lytta cinerea*," how can the reader tell whether we mean the species described under that name by Foerster, or the very distinct species described under the very same name "*cinerea*" by Fabricius? Whereas, if we add the author's name, all doubts upon the subject are at once removed; and we can snap our fingers at those wearisome and interminable disputes about the priority of names and the law of priority, which take up so much space in scientific papers, while they add absolutely nothing to our knowledge of the facts recorded by the finger of God in the great book of Nature.

upper surface of the insect is covered with it. In other insects, which do not indulge in this singular practice, the vent is situated either at the extreme tip of the abdomen or on its lower surface.

There are several other larvæ, feeding upon other plants, which commonly wear cloaks of this strange material, among which may be mentioned one which is very common upon the Sumach, and which produces a jumping, oval Leaf-beetle (*Blepharida rhois*, Foerster), about a quarter of an inch long, and of a yellow color, speckled with brick-red. The larvæ of certain Tortoise-beetles (*Cassida*), some of which feed on the Morning Glory and the Sweet Potato vines, adopt the same practice, but in their case there is a forked process at the tail which curves over their backs and receives the requisite supply of excrement.

Many authors have supposed that the object of the larva, in all these cases, is to protect its soft and tender body from the heat of the sun. This can scarcely be the correct explanation, because then they would throw away their parasols in cold cloudy weather, which they do not do. In all probability, the real aim of Nature, in the case of all these larvæ, is to defend them from the attacks of birds and of cannibal and parasitic insects.

There are two broods of this species every year. The first brood of larvæ may be found on the potato vine toward the latter end of June, and the second in August. The first brood stays underground about a fortnight before it emerges in the perfect beetle state; and the second brood stays there all winter, and only emerges at the beginning of the following June. The perfect beetle (Fig. 43) is of a pale yellow color, with three black stripes on its back, and bears a general resemblance to the common Cucumber-beetle (*Diabrotica vittata*, Fabr., Fig 44). From this last species, however, it may be readily distinguished by the remarkable pinching in of the sides of its thorax, so as to make quite a lady-like waist there, or what naturalists call a "constriction." It is also on the average a somewhat larger insect, and differs in other less obvious respects. As in the case of the Colorado Potato-beetle, the female, after coupling in the usual manner, lays her yellow eggs (Fig. 42 *d*) on the under surface of the leaves of the potato plant. The larvæ hatching from these require about the same time to develop, and when full grown descend in the same manner into the ground, where they transform to pupæ (Fig. 42 *c*) within a small oval chamber, from which in time the perfect beetle comes forth.

[Fig. 43.]

[Fig. 44.]

The Three-lined Leaf-beetle, in certain seasons, is a great pest in the Eastern States; but, it has never yet occurred in the Valley of the Mississippi in such numbers as to be materially injurious.

THE CUCUMBER FLEA-BEETLE—*Haltica cucumeris.**—Harris.

(Coleoptera, Chrysomelidæ.)

[Fig. 45.]

This minute Beetle (Fig. 45) belongs to the Flea-beetles (*Haltica* family), the same sub-group of the Leaf-beetles (*Phytophaga*) to which also appertains the notorious Steel-blue Flea-beetle (*Haltica chalybea*, Illiger), that is such a pest to the vineyardist. Like all the rest of the Flea-beetles, it has its hind thighs greatly enlarged, which enables it to jump with much agility. It is not peculiar to the potato, but infests a great variety of plants, including the cucumber, from which it derives its name. It operates by eating minute round holes into the substance of the leaf which it attacks, but often not so as to penetrate entirely through it. In South Illinois whole fields of potatoes may often be observed looking seared and yellow, and with their leaves riddled with the round holes made by this insect. The larva feeds internally upon the substance of the leaf, like that of the closely-allied European Flea-beetle of the turnip (*Haltica nemorum*, Linn.); and, from its near relationship to that insect, we may infer that it goes underground to assume the pupa state, that it passes through all its stages in about a month, and that there are two or three broods of them in the course of the same season.

THE COLORADO POTATO-BEETLE—*Doryphora 10-lineata*, Say.

(Coleoptera, Chrysomelidæ.)

ITS PAST HISTORY AND FUTURE PROGRESS.

[Fig. 46.]

Up to the autumn of 1865, it was generally supposed by economic entomologists, that this destructive insect had existed from time immemorial in the Northwestern States, feeding upon some worthless weed or other; and that of late years, from some unexplained cause, it had all of a sudden taken to attacking the potato-plant. In October, 1865,

* Erroneously considered by some authors as identical with the *Haltica pubescens* of Illiger. In this last species, according to Dr. J. L. LeConte, the thorax, instead of being shining, as in our insect, is opaque, with large, dense punctures.

Mr. Walsh showed that originally its exclusive home was in the Rocky Mountains, where it had been known to exist for at least forty-five years feeding upon a wild species of potato peculiar to that region (*Solanum rostratum*, Dunal); that when civilization marched up to the Rocky Mountains, and potatoes began to be grown in that region, it gradually acquired the habit of feeding upon the cultivated potato; that in 1859, spreading eastward from potato patch to potato patch, it had reached a point one hundred miles to the west of Omaha city, in Nebraska; that in 1861, it invaded Iowa, gradually, in the next three or four years, spreading eastward over that State; that in 1864 and 1865, it crossed the Mississippi, invading Illinois on the western borders of that State, from the eastern borders of North Missouri and Iowa, upon at least five different points on a line of two hundred miles; and that in all probability it would in future years "travel onwards to the Atlantic, establishing a permanent colony wherever it goes, and pushing eastward at the rate of about fifty miles a year." (*Practical Entomologist*, Vol. I, No. 1.) A remarkable peculiarity in the eastern progress of this insect was subsequently pointed out by the same writer, in 1866, namely, that "in marching through Illinois in many separate columns, just as Sherman marched to the sea, the southern columns of the grand army lagged far behind the northern columns." (*Ibid*, II, p. 14.)

Now, let us see how far the predictions above, have been verified By the autumn of 1866, the Colorado Potato-beetle, which appears to have invaded the south-west corner of Wisconsin at as early a date as 1862 (*Ibid*, II, p. 101), had already occupied and possessed a large part of the cultivated or southern parts of that State; and in Illinois if we draw a straight line to connect Chicago with St. Louis, nearly all the region that lies to the north-west of that line was overrun by it. It subsequently invaded parts of South Illinois, occurring in Union, Marion, and Effingham counties, in 1868; and already in 1867 it had passed through the eastern borders of North and Central Illinois into Western Indiana, and the south-west corner of Michigan; and finally, in 1868 it made its appearance in many different places in Indiana, and as the following communication from a Cincinnati correspondent of the *Ohio Farmer*, under date of July, 1868, will show, it has even spread into Ohio.

"About three years ago when in your office at Cleveland, you presented me with samples of this devastating insect, the first I had seen; they have been preserved in the collection of one of the best entomologists of Ohio. You had received the beetles from some correspondent in Iowa, where it was then ravaging the crops and where it continues to be very destructive. We soon learned that the insects were progressing eastward at the computed rate of about thirty miles a year, and we began to calculate the time when we might expect its appearance in Ohio—which we did not anticipate for some years.

"Having crossed the Mississippi at Rock Island the insects soon traversed the State of Illinois and reached the shores of Lake Michigan, where it might have met a watery grave, but, unfortunately its course was only deflected southward, and there were other cohosts of the invaders, traversing lower parallels, so that by convergence, the force was multiplied and great fears were anticipated by the potato-growers of Northern Indiana and Ohio, and it was supposed that Northern Ohio would be invaded before the Southern portion of this State.

"At the last annual meeting of the Indiana Horticultural Society, in January 1868, the existence of this insect was reported in several counties in the north-western part of that State during 1867, leading us to apprehend that the day of their approach to us was not so distant as we had fondly hoped. Correspondents now inform us that this beetle has reached Lafayette, Indianapolis, Danville, and other points of central Indiana, so that its progress eastward continues with increasing speed.

"We have now to record the actual presence of the Ten-lined Spearman, (*Doryphora* 10-*lineata*,) in the south-western corner of Ohio, a very few specimens of this pest having been taken within the past week in Hamilton county."

Thus it appears that its average annual progress towards the east has been upwards of seventy miles. At the same rate of progression it will touch the Atlantic ocean in about ten years from now, or A. D. 1878.

"But," it will be asked, "how could any entomologists make the mistake of supposing that the Colorado Potato-beetle had always existed in the Northwestern States?" The answer is, that, as was proved three years ago in the article already referred to they inadvertently confounded together two entirely distinct, but very closely allied species, the bogus Colorado Potato-beetle (*Doryphora juncta*, Germar), and the true Colorado Potato-beetle (*Doryphora* 10-*lineata*, Say). The former of these has existed in the South-west from time immemorial, and has long since been known to feed in the larva state upon the horse-nettle (*Solanum carolinense*, Linn,) a wild plant which is exceedingly adundant in our own State. In 1863 Mr. Glover stated that he "had found an insect similar to the Ten-striped Spearman [or true Colorado Potato-beetle] on the common horse-neetle in Georgia." (*Agr. Department Rep.*, p. 579). In 1867 he assured me that this insect, found by him on the horse-nettle in Georgia four years before, was the bogus Colorado Potato-beetle (*D. juncta*,) and that "a Mr. Walter had also found it feeding upon the Egg-plant in Montgomery, Alabama." I discovered this same species in Kentucky in 1864, feeding in conjunction with its larvæ upon a plant, which could have been nothing else but the horse-nettle; and last fall I met with it in great numbers, in St. Louis and Jefferson counties in this State, feeding upon the same plant, in company with its larvæ; and in one instance the larvæ of both the true and the bogus species occurred in company. Thus it appears to inhabit at least five southerly regions, namely South Illinois, Missouri, Kentucky, Georgia and Alabama.

The true Colorado Potato-beetle as has been already stated, only immigrated into Illinois in 1864, and in its native home, the Rocky Mountains, feeds naturally upon another wild species of potato, which is quite distinct from the horse-nettle, and is peculiar to the Rocky Mountain region. Again, the former species has never yet been known to attack the cultivated potato, and in all likelihood never will do so; for, as it has existed in all likelihood never will do so; for, as it has existed in Illinois, for at least 14 years, and in Georgia for at least 44 years, without ever having been known to attack this plant, which has been growing all that time in these two States, it is not at all probable that it will do so at any future time. The latter species, on the other hand, acquired this habit, as was shown before, in the region of the Rocky Mountains, when for the first time the potato was introduced there, some twenty years ago; and from that region the potato-feeding race of this insect has since been spreading further and further every year towards the east. Finally the bogus Colorado Potato-beetle is more peculiarly a southern species, occurring in the more southerly portion of Illinois, and in Missouri, Kentucky, Georgia, and probably Alabama, while the true Colorado Potato-beetle is originally an Alpine species, its native home being the canons (kanyons) of the Rocky Mountains, and it therefore thrives best and spreads fastest in the more northerly regions, such as Nebraska, Iowa, Minnesota, Wisconsin and North Illinois; while in South Illinois, Missouri, and Kansas, it neither thrives so well nor spreads so rapidly.

The question whether the true Colorado Potato-beetle has existed for an indefinitely long time in the country that lies to the east of the Mississippi river, or whether it is not the bogus Colorado Potato-beetle that has there been mistaken for it, while the true Colorado Potato-beetle has in reality immigrated into that country from the Rocky Mountain region within the last four or five years, may seem to some of merely theoretical interest. It is, however, of great practical importance. On the first supposition it is not probable that this bitter enemy of the potato will travel onwards and onwards towards the Atlantic; on the second supposition it will most likely traverse Ohio within a year or two, spread like a devouring flame through the great potato-growing State of Michigan, and finally pass eastwards into Pennsylvania, New York, and New England. I shall, therefore, briefly point out the minute but invariable characters which distinguish them both in the larva and perfect beetle states.

I had an excellent opportunity of comparing the larvæ of *juncta* with those of *10-lineata*, from alcoholic specimens which were kindly sent to Mr. Walsh by Mrs. H. C. Freeman, of Cobden, Illinois, and from numerous living specimens which I found around St. Louis.

At Figure 46, the true Colorado Potato-beetle is represented in all its varied stages; *b*, *b*, *b* representing the larvæ of three different growths and sizes. In the annexed Figure 47, *b*, *b*, represents the full grown larvæ of the bogus Colorado Potato-beetle. It will be seen at once that the head of the former is black, that the first joint behind the head is pale and edged with black behind only, that there is a double row of black spots along the side of the body, and that the legs are black, the ground-color of the body being of a Venetian-red. In the other larva (Fig. 47 *b*), on the contrary, the head is of a pale color, the first joint behind the head reddish-brown and edged all round with black; there is but a single row of black spots along the side of the body and the legs are pale, while the ground color of the body is of a pale cream, tinged with pink or flesh color. Such are the distinguishing characteristics of the two larvæ; but it is an interesting fact that these characters are not always constant. Thus the individuals of the second (last summer's) brood of 10-*lineata* larvæ which fed on the horse-nettle in my garden were all of them much paler than were those of the first, potato feeding brood, from which they had descended; and furthermore the lower row of spots was very indistinct and in many entirely obsolete, while the head, instead of being black was entirely brown. Whether this variation from the normal type was due to the food-plant or not, I shall not at present offer an opinion, but I should have been doubtful about the species had I not bred the perfect beetle (10-*lineata*) from them. Again as I shall immediately show the young larva of *juncta* similates in its markings the mature larva of 10-*lineata*.

[Fig. 47].

The eggs of 10-*lineata* (Fig. 46, *a*, *a*) are of a translucent orange-red color, while those of *juncta* (Fig. 47, *a*, *a*) are whitish, with a faint tinge of flesh-color, and still more translucent. The newly hatched larvæ of the former are of a dark Venetian-red, and they become lighter as they grow older, while the newly hatched larvæ of the latter have the body as light as the full grown individuals. Singularly enough, however, the newly hatched larvæ of *juncta* instead of having the light yellow head and the single row of spots of the mature individuals, have a brown head and *two* rows of spots, the lower being less distinct than the upper row, and placed exactly in the same position as the lower row on the *mature* larvæ of 10-*lineata* (see Fig. 46 *b*, lower figure).

I subjoin a more full description of *Doryphora juncta*. That of the larva of *Doryphora* 10-*lineata* will be found in Dr. Fitch's *N. Y. Reports*, Vol. III, pp. 231–2. According to Dr. Fitch, the ground color of this last larva is "pale-yellow" in the mature state; according to Dr. Shimer, in his excellent article on the preparatory stages of this insect, it is "orange." In the immature larvæ it is almost always of a dull Venetian-red, though in the mature larvæ the color becomes lighter. Indeed in some instances it becomes almost as pale as that of *D. juncta.* I saw a number of such pale individuals among the late broods of last summer, though I had never seen them so pale before, notwithstanding I have witnessed great numbers of them every year, since 1863.

DORYPHORA JUNCTA, Germar.—*Mature larva.*—General color a pale yellowish flesh-color. Head bright gamboge-yellow, with the antennæ placed behind the base of the mandibles, short and very robustly conical, three-jointed, joints 2 and 3 black. Precisely as in 10-*lineata,* there are six small simple black eyes upon each side, one pair longitudinally arranged and placed below the antenna, the other two pairs arranged in a square and placed a little above and behind the antenna; tip of the mandibles black. Body, with the dorsum of joint 1 composed of a separate transverse horny plate, rounded at the sides, of a rich shiny vandyke-brown, with the edges somewhat raised, and jet black and with a fine line of a lighter color running through the middle from the posterior to the anterior edge. Joints 1—3 each, with a lateral horny black tubercle, that of joint 1 placed below and behind the horny prothoracic plate, and enclosing a spiracle. Joints 4—11 each with a similar lateral tubercle enclosing a spiracle; but the row composed of these eight tubercles is placed a little above the row of three tubercles on joints 1—3, and the last four of the eight are gradually smaller and smaller, until that on joint 8 is reduced to a simple black spiracle. Legs pale yellow; coxæ exteriorly dark brown, the two hinder pairs each more and more so, with a geminate horny plate above each, which becomes more and more brown in each successive pair. An exterior dusky dot, or small spot, on the tip of the femur and of the tibia. Tarsus small, one-jointed, brown, and with a black claw.

The body has a distinct translucent dorsal heart-line, and has usually a shade of the same color both above and below the lateral row of black tubercles; while there are two transverse dark-brown bands across the extreme tip of the body, which is used as an anal proleg. This larva, when well fed, is very smooth and swollen, though it soon becomes wrinkled after fasting. The pink tint of the body is more intense on the neck and between the legs.

Now let us see what are the differences in the perfect beetle state of these two insects, in which state even a practised entomologist would, at first sight, be apt to confound them together. Indeed, so minute are the differences, that in a drawing of the natural size, it is scarcely possible to exhibit them, but with the greatly enlarged leg and wing-case of each species, which are given in the foregoing figures, we shall readily be enabled to do so. Figure 46, *d*, *d*, exhibits the true Colorado Potato-beetle; Figure 47, *c*, the bogus Colorado Potato-beetle, each of its natural size. Figure 46, *e*, shows the *left* wing-case enlarged, and Figure 46, *f*, an enlarged leg of the former; Figure 47, *a*, the *left* wing-case enlarged, and Figure 47, *e*, an enlarged leg of the latter. On a close inspection it will be perceived that in the former (Fig. 46, *e*) the boundary of each dark stripe on the wing-cases, especially towards the middle, is studded with confused and irregular punctures, partly inside and partly outside the edge of the dark stripe; that it is the third and fourth dark stripes, counting from the outside, that are united behind; and that in the leg both the knees and the feet are black. In the latter (Fig. 47, *d*), on the contrary, the dark stripes are accurately edged by a single regular row of punctures placed in a groove (*stria*); it is the second and third stripes—not the third and fourth—counting from the outside, that are united behind, the space between them being almost always brown; and the leg is entirely pale, except a black spot on the middle of the front of the thigh.

The spots on the thorax, in either of the above two species, are normally eighteen in number, arranged in the same very peculiar pattern which may be seen both in Figure 46, *d*, *d*, and in Figure 47, *c*; and precisely the same variations in this complicated pattern occur in either species.

Thus, these two beetles differ essentially from one another upon a strict comparison; but the general resemblance is so great that it is not to be wondered at that the two have been confounded together by several otherwise well qualified observers.

HABITS OF THE COLORADO POTATO-BEETLE.—This insect *can* fly, though it does so very reluctantly and only during the heat of the day. Its wings, like those of several allied species, are of a bright rose-color, and with its cream-colored body, and the five black stripes upon each wing-case, it presents a beautiful appearance as it flies abroad in the clear light of the sun. Its transformations were first made known by myself in the *Prairie Farmer* for August 8, 1863. Subsequently, in 1866, Dr. Shimer, of Mt. Carroll, detailed some additional particulars bearing on its habits, in a paper which he published in the *Practical Entomologist* (vol. 1, pp. 84–85). In the latitude of St. Louis there are three broods during the year, the last brood wintering over in the beetle state underground. They are usually dug up in the spring of the year in land that had been planted to potatoes the year before. The beetles issue of their own accord from the ground about the first of May, and the last brood of beetles enters the ground to hybernate during the month of October. Though, in general terms, this beetle may be said to be three-brooded, yet it may be found at almost any time of the year in all its different stages. This is owing to the fact that the female continues to deposit her eggs in patches from time to time—covering a period of about forty days; and also from the fact that among those larvæ which all hatch out in one day, some will develop and become beetles a week and even ten days earlier than others. Thus it may be that some of the late individuals of the third brood pass the winter in the pupa state, though the normal habit is to first transform to beetles. Each female is capable of depositing upwards of a thousand eggs before she becomes barren, and in from thirty to forty days from the time they were deposited, they will have produced perfect beetles. These beetles are again capable of depositing eggs in about two weeks after issuing from the ground, and thus, in about fifty days after the egg is laid, the offspring begins to propagate. The pupa of the Colorado Potato beetle is represented at Figure 46, *c*. It is formed in a little cavity which the larva had made perfectly smooth and hard, and it is of the same color as the larva. The beetle, on first emerging from it, is quite pale and soft, without any markings whatever.

Unlike many other noxious insects, this larva is not a general feeder, but is confined to plants belonging to the potato family (*Solanaceæ*), and especially to the genus to which the potato belongs (*Solanum*). Occasionally it feeds on the tomato, on the ground-cherry (*Physalis*), and on the imported Jamestown-weed, or gympson-weed (*Datura*). It prefers the horse-nettle (*Solanum carolinense*) to some varieties of the potato, and were it not that the nettle is considered a nuisance, on account of the difficulty of eradicating it when once introduced, it would be a good plan to encircle a potato field with a row of nettles, so as to concentrate the insects, and thus more readily destroy them. It is also even more destructive to the egg-plant than to the potato. Now, the egg-plant, the horse-nettle, and the potato, all three of them belong to the same genus (*Solanum*), as the wild plant upon which the larva originally fed in the Rocky Mountain region; but the egg-plant and the horse-nettle are botanically more closely related to the last than is the potato; being, like the Rocky Mountain potato, covered with thorny prickles, while the cultivated potato is perfectly smooth. On the other hand, the cultivated potato is much more nearly related to the Rocky Mountain species than is the tomato; which last has, by modern botanists, been removed from the genus to which the other two appertain, and placed in a genus by itself. It would seem, therefore, that the closer a plant comes to the natural food-plant of the insect, the better the insect likes it.

The beetles have been sent to me, as taken from other plants, and even from the raspberry, but I could never succeed in making them feed on any plant that did not belong to the potato family, though I am informed by my friend, Edgar Sanders, of Chicago, that they greedily attack the tubers after they are dug, and he has found as many as six in a single potato.

It is undoubtedly a most singular and noteworthy fact that, out of two such very closely allied species as the bogus and the true Colorado Potato-beetles, feeding respectively in the first instance upon very closely allied species of wild potato (*Solanum rostratum* and *S. carolinense*), the former should have pertinaciously refused, for about half a century, to acquire a taste for the cultivated potato, with which it was all the time in the closest and most immediate contact, while the latter acquired that taste as soon as ever it was brought into contact with that plant. But, after all, this is not so anomalous and inexplicable as the fact that the Apple-maggot Fly (*Trypeta pomonella*, Walsh), which exists both in Illinois, New York, and New England, and the larva of which feeds in Illinois upon the native haws, and has never once been noticed to attack the imported apple there, should, within the last few years, have suddency fallen upon the apple, both in New York and New England, and in many localities there, have become a more grievous foe to that fruit than even the imported Apple-worm (*Carpocapsa pomonella*, Linn.)*

Thinking that the bogus Colorado Potato-beetle might be compelled to feed on the potato in a state of confinement, I gave it every opportunity; but though the larvæ, when transferred from the horse nettle, fed more or less on potato leaves, they invariably became sickly and eventually died. But even if they had actually fed upon potato leaves quite freely in a state of confinement and developed into bee-

* See on this subject the First Annual Report on the Noxious Insects of Illinois, by Benj. D. Walsh, pp. 29-30, in the Transactions of the Illinois State Horticultural Society for 1867.

tles it by no means follows that the mother beetle would deposit her eggs upon the potato in a state of nature, and thereby compel her future progeny to feed upon that plant. That she will do so upon her natural food-plant, the horse-nettle, we know; and, according to Mr. Walter of Alabama, she will do so upon the egg-plant, which is thorny like the horse-nettle. But apparently she is indisposed to go one step further, and lay her eggs upon a smooth species of the same botanical genus, namely the potato.

Natural Remedies.—Persons not familiar with the economy of insects are continually broaching the idea that, because the Colorado Potato-beetle is in certain seasons comparatively quite scarce, therefore it is about to disappear and trouble them no more. This is a very fallacious mode of reasoning. There are many insects—for instance, the notorious Army-worm of the north (*Leucania unipuncta*, Haworth)—which only appear in noticeable numbers in particular years, though there are enough of them left over from the crop of every year to keep up the breed for the succeeding year. There are other insects—for instance the Canker-worm (*Anisopteryx vernata*, Peck)—which ordinarily occur in about the same numbers for a series of years, and then, in a particular season and in a particular locality, seem to be all at once swept from off the face of the earth. These phenomena are due to several different causes, but principally to the variation and irregularity in the action of cannibal and parasitic insects. We are apt to forget that the system of Nature is a very complicated one—parasite preying upon parasite, cannibal upon cannibal, parasite upon cannibal, and cannibal upon parasite—till there are often so many links in the chain that an occasional irregularity becomes almost inevitable. Every collector of insects knows, that scarcely a single season elapses in which several insects, that are ordinarily quite rare, are not met with in prodigious abundance; and this remark applies, not only to the plant-feeding species, but also to the cannibals and the parasites. Now, it must be quite evident that if, in a particular season, the enemies of a particular plant-feeder are unusually abundant the plant-feeder will be greatly diminished in numbers, and will not be able to expand to its ordinary proportions until the check that has hitherto controlled it is weakened in force. The same rule will hold with the enemies that prey upon the plant-feeders, and also with the ememies that prey upon those enemies, and so on *ad infinitum*. The real wonder is, not that there should be occasional irregularities in the numbers of particular species of insects from year to year, but that upon the whole the scheme of creation should be so admirably dove-tailed and fitted together, that tens of thousands of distinct species of animals and plants are able permanently to hold their ground, year after year, upon a tract of land no larger than an ordinary State.

To illustrate the decrease in its numbers which took place in the State of Iowa from 1867–8, I will state that Mr. Henry Tilden, of Davenport, who had previously made tomato and potato growing a specialty, was forced to go to raising small grains on its account, in 1867, having lost 30 acres of potatoes by its ravages in 1866; while in 1867 Mr Suel Foster, of Muscatine, Iowa, offered a large premium to any one who would insure his crop of potatoes. Now I have received numbers of letters which go to show that the damage done to potatoes in Iowa in 1868 was comparatively very slight, and the following article which Mr. Foster published in the *Prairie Farmer* of May 16th 1868, sufficiently demonstrates that Mr. F. would have been the loser, had any insurance company seen fit to insure his crop on his own terms:

"For three years past I have given the most discouraging accounts of the ruinous destruction of our almost indispensable potato crop. I now have a word of encouragement. Last year I planted very sparingly of potatoes; the year before, by great perseverance, I succeeded in raising a few Early Goodrich and Harrison, by continual picking and killing the bugs, and last year planted the product on a new piece of land where no potatoes had been raised; but the bugs found them as soon as they were up; I picked the bugs awhile, then gave them up to their destruction, and the potatoes were nearly destroyed. About the first to the tenth of June the bugs began to diminish. We found the little red and black spotted lady bug quite numerous and active, eating the eggs of the potato bug. I didn't believe those little lady bugs could possibly destroy enough of the eggs of the potato bugs to materially check their increase; but there were but very few of the second brood that hatched in this part of the country, and our late and strong growing potatoes were a full crop.

"What became of the bugs that were so numerous in May and the first of June? The lady bug, with a little assistance from a few other insects, destroyed their eggs. Last May the weather was very wet and cold, yet the bugs increased, and although more stiff and clumsy than in dry, warm weather, they were hearty at their food. Had June been cold and wet, I should have thought their disappearance was caused by that; but June was a very favorable time for their increase and spread on the wing by night. The Colorado potato bugs nearly all disappeared here in June, and not a bug have we seen in plowing and digging in the ground this spring, while in former seasons we used to find them plentifully. I believe some will make their appearance this year, but I fully believe that the same cause which destroyed them so early last year—the lady bug and others, some of which preyed upon the young potato bugs—will prevent their increase this year. If the above are not the facts in this case, can any one tell us facts and theories that are more reliable? It is true, I am not as positive about this as if I had met a regiment of rebels, and had counted the dead and prisoners, to tell what had become of them. But we, in this region, do not expect the bug this year, and are planting potatoes with very little hesitation. Your readers may rely upon this as the fate of the potato bug for the present, and I will write you again in a month, or as soon as I get additional news from him.

"The Illinois correspondent of the *Country Gentleman*, writing from Champaign county, says:

"Those plowing old potato ground where these creatures operated extensively last year, find the ground full of the dormant wretches. We, at Muscatine, Iowa, will lend them our Benson's Horse Power Potato Bug Killer, but we can't spare our lady bugs."

The following enemies of the Colorado Potato-beetle, are among the most prominent which have been instrumental in checking its ravages during the past summer.

THE COLORADO POTATO-BEETLE PARASITE—*Lydella doryphoræ*, N. Sp.
(Diptera Tachinidæ.)

This fly (Fig. 48) has probably been more efficient in checking it than any one other insect, at least in our own State. Until last year no parasitic insect whatever was known to prey internally upon it, but this fly destroyed fully ten per cent. of the second brood and fifty per cent. of the third brood of potato-beetles that were in my garden. It bears a very close resemblance, both in color and size, to the common house fly, but is readily distinguished from the latter by its extremely brilliant silver-white face.

[Fig. 48.]

It may be seen throughout the summer months flying swiftly from place to place, and deftly alighting on fence or wall, where, basking in the sun, its silvery face shows to good advantage. As with the rest of the family to which it belongs, the habit of the female is to attach a single egg externally to the body of the Potato-beetle larva. This egg subsequently hatches into a little footless maggot, which burrows into the body of its living victim, and eventually destroys it, but not until it has gone underground in the usual manner. The victimized larva instead of becoming a pupa, and eventually a beetle, as it would have done had it not been attacked, begins to shrink as soon as it enters the ground, and gradually dies; while inside its shriveled skin the parasitic maggot contracts into a hard brown pupa, and in due time issues forth in the shape of the fly which I have figured. I am indebted to Mr. Wm. LeBaron, of Geneva, Illinois, for the generic determination of this fly. It belongs to the genus (or sub-genus *Lydella* Macquart, and is very closely allied to *Tachina* proper, with which it could properly be united, did not the great number of species require a division as a matter of necessity. I subjoin a more detailed description of the fly:

LYDELLA DORYPHORÆ, New Species.—Length 0.25. Alar expanse 0.48. Antennæ black. Palpi fulvous. Face silvery white. Front silvery, tinted with pale golden-brown, with a broad middle stripe black. Thorax cinereous with imperfect black stripes. Abdomen black and silvery-ash, changing into each other when viewed from different angles. When viewed from above: first segment deep black with a posterior border of silver-ash very narrow in the middle, much widened laterally, but abreviated at the sides of the abdomen. The other segments with the basal half silvery-ash, terminal half black. Legs black. Fourth longitudinal vein of the wings straight after the angle. Posterior transverse vein arcuate.

Described from numerous bred specimens.

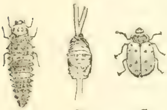
LADYBIRDS.—In the egg state the Colorado Potato-beetle is preyed upon by no less than four distinct species of Ladybirds. Foremost among them is the Spotted ladybird (*Hippodamia maculata*, DeGeer) which is one of our most common species and is of a pink color, marked with large black spots as in Figure 49. Next comes the Nine-spotted ladybird (*Coccinella 9-notata*, Herbst) which is of a brick-red color and marked with 9 small black spots as in Figure 50. Next, the Thirteen-spotted ladybird (*Hippodamia 13-punctata*, Linn.) which is also of a brick-red color but marked with 13 black spots as in Figure 51. And last but not least, the little species figured at 52, *a*, which may be known as the Convergent ladybird (*Hippodamia convergens*, Guer.) and which is of an orange-red color marked with black and white as in the figure. This last species alone has been of immense benefit in checking the ravages of the Potato-beetle. Its larva is represented of the natural size at Figure 52, *a* its colors being blue, orange and black; when full grown it hangs by the tail to the underside of a stalk or leaf and transforms into the pupa represented at Figure 52, *b*. In this state it is of the exact color of the Colorado beetle larva and is doubtless quite often mistaken for that larva and ruthlessly destroyed. It may readily be distinguished however by its quiescence, and let every potato grower learn well to recognize it and spare its life! The larvæ of all these ladybirds are more bloodthirsty in their habits than the perfect beetles, and the larva of the little Convergent ladybird is so essentially a cannibal that whenever other food fails, it will turn to and devour the helpless pupæ of its own kind. It is a rather cruel and withal a somewhat cowardly act to thus take advantage of a helpless brother; but in consideration of its good services, we must overlook these unpleasant traits in our little hero's character! All these larvæ bear a strong general resemblance, and with the aid of Figure 52 *a* and the annexed Figure 53, a good idea may be obtained of them. They run with considerable speed, and may be found in great numbers upon almost all kinds of herbage. The larvæ of certain species that prey upon the Hop Plant-louse in the East are well known to the hop-pickers as "black niggers" or "serpents," and are carefully preserved by them as some of their most efficient friends.

[Fig. 49.]

[Fig. 50.]

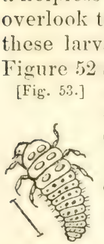
[Fig. 51.]

[Fig. 52.]



A B C

[Fig. 53.]



The eggs of ladybirds greatly resemble those of the Colorado Potato-beetle, and are scarcely distinguishable except by their smaller size and by a much smaller number being usually collected together in a single group. As these eggs are often laid in the same situation as those of the potato-feeding insect, care must be taken by persons who undertake to destroy the latter, not to confound those of their best friends with those of their bitterest enemies.

[Fig. 54.]

[Fig. 55.]

THE SPINED SOLDIER-BUG.—In the larva state the Colorado Potato-beetle is extensively depredated on, both in Illinois, Missouri and Iowa, by the Spined Soldier-bug (*Arma spinosa*, Dallas), which is of an ochre-yellow color and is represented with one pair of wings closed and the other pair extended, in the annexed Figure 54.—Thrusting forwards his long and stout beak, he sticks it into his victim, and in a short time pumps out all the juices of its body and throws away the empty skin. He belongs to a rather extensive group (*Scutellera* family) of the true bugs (*Heteroptera*), distinguishable from all others by the very large scutel, which in this genus is triangular, and covers nearly half his back. Most of the genera belonging to this group are plant-feeders, but there is a sub-group (*Spissirostres*) to which our cannibal friend belongs, characterized by the robustness of their beaks, and all of these, seem to be cannibals. To illustrate to the eye the difference between the beaks of the cannibal sub-group and the plant feeding sub-groups of this family, Figure 54 *a* gives a magnified view of the beak of our insect seen from below, and Figure 54 *c* a similarly magnified view of that of a plant-feeder belonging to the same family (*Euschistus punctipes*, Say), which is so nearly of the same size, shape and color as our cannibal friend, that at first sight many persons would mistake one for the other. The Spined Soldier-bug, however, may be at once distinguished from all allied bugs, whether plant feeders or cannibals, by the opaque brown streak at the transparent and glassy tip of its wing-cases.

It has sometimes been reported that the common Squash-bug (*Coreus tristis*, DeGeer) preyed upon the Colorado Potato-beetle; but there can be little doubt but that the Spined Soidier-bug has in these instances been mistaken for it. The colors of the two are somewhat similar but in the eyes of an entomologist the Squash-bug looks as different from the Spined Soldier bug as a cow does from a horse! The figure (55, *a*) of the former which is given above, opposite to that of the latter, will enable any one to recognize the difference, while its magnified beak (Fig. 55, *b*) indicates by its slenderness that it is a plant-feeder.

The Spined Soldier-bug by no means confines himself to Potato-beetle larvæ, but attacks a great number of other insects.

[Fig. 56.]

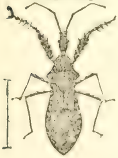
The Bordered Soldier-bug.—This is another insect which attacks the Colorado Potato-beetle. It belongs to the same sub-group, and has the same kind of short robust beak as the preceding, but unlike that species, it is so conspicuously and prettily marked that it cannot easily be confounded with any other. Its colors are dark olive-green and cream-color, marked as in Figure 56. It is not so common as the preceding species.

The Many-banded Robber.—Another true bug, still more elegantly marked than the preceding, (*Harpactor cinctus*, Fabr.,) was observed by Dr. Shimer, of Mt. Carroll, Illinois, to attack the Colorado larvæ, and I found it attacking the same larva in our own State the present year. Like the Spined Soldier-bug, this species is common, and inhabits trees more commonly than herbaceous plants. But it belongs to an entirely different group of the true Bugs (*Reduvius* family), all of which, without exception, are cannibals, and are characterized by a short, robust, curved beak (Fig. 57, *b*, profile view, magnified). Figure 57, *a*, gives a magnified view of this bug, the colors being yellow, white and black, and it may be known by the name of the Many-banded Robber.

[Fig. 57.]

The Rapacious Soldier-bug.—Still another bug belonging to the very same group as the preceding (*Reduvius raptatorius*, Say), I have found sucking out the juices of the Colorado larva, and specimens were sent to me by S. H. Kriedelbaugh, of Clarinda, Iowa, who found it with the same commendable habit in that State. This bug is represented at Figure 58. It is of a light brown color, and may be known by the name of the Rapacious Soldier-bug.

[Fig. 58].



The above four insects are all of them true bugs, and attack the larvæ of the Colorado Potato-beetle with the only offensive weapon that they have—their beak. The four following (Figs. 59 to 62) are all beetles, and are consequently provided with jaws, so that they are able to eat up their victims bodily; and all of them, except the first, which is confined to southerly latitudes, are common throughout the Western States. Most, if not all, of them prey indifferently upon the Colorado larva and the perfect insect produced from it.

[Fig. 59.]

[Fig. 60.]

THE VIRGINIAN TIGER-BEETLE.—This beetle (*Tetracha Virginica*, Hope) is of a dark metallic green color, with brown legs, and the annexed cut (Fig. 59) will enable its recognition without much difficulty.

THE FIERY GROUND-BEETLE.—This beetle (*Calosoma calidum*, Fabr.) has already been treated of on page 89 where its larva is illustrated and termed the "Cut-worm lion." The beetle is of a black color, with coppery dots, as shown in Figure 60, and has also been found to prey on the Colorado larva.

[Fig. 61.]

[Fig. 62.]

THE ELONGATE GROUND-BEETLE.—This pretty and conspicuous insect (*Pasimachus elongatus*, *Lec.*) is another enemy of the Colorado Potato-beetle. It is of a polished black color edged with deep blue, and is of a rather elegant form, being represented at Figure 61.

THE MURKY GROUND-BEETLE.—Finally this beetle (*Harpalus caliginosus*, Say) which is of a dull black color, and which is represented life-size at Figure 62, has the same commendable habit as the other three. There are ten or twelve other beetles mostly of small size, which have the same habits as the above; but they would not be readily identified from an uncolored drawing.

BLISTER BEETLES.—Strange as it may seem, the Striped Blister-beetle (Fig. 39, p. 97), and the Ash-gray Blister-beetle (Fig. 40, *a*, p. 98), which have already been described as very injurious to the potato, seem to have the redeeming trait of also preying occasionally on the larva of the Colorado Potato-beetle. It was at first difficult to believe or reconcile the statements to this effect which were reported during the summer, but there have been so many of them that the fact may now be considered as indisputable, and these two Blister beetles may therefore, with propriety, be placed in the list of the enemies of the Colorado beetle. I by no means advise their protection, however, on this account; for I believe that what little good they accomplish is much more than outweighed by the injury they do us. As authorities for these statements may be quoted, among many others, Abel Proctor, of Jo Daviess county, Ill., and T. D. Plumb, of Madison, Wis.

"When dog eats dog, then comes the tug of war;"

when rogues fall out, honest men come by their own. And now that certain potato-beetles have taken to feeding upon other potato-beetles, the American farmer may justly lift up his voice and shout for joy.

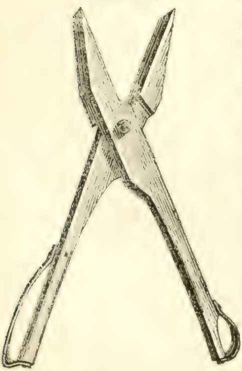
Neither ducks, geese, turkeys nor barn-door fowls will touch the larva of the Colorado-beetle when it is offered to them; and there are numerous authentic cases on record, where persons who have scalded to death quantities of these larvæ, and inhaled the fumes from their bodies have been taken seriously ill, and even been confined to their beds for many days in consequence.

ARTIFICIAL REMEDIES.—It only remains to say something on the most approved method of fighting the Colorado Potato-beetle. A great deal may be effected by raising your potatoes at a point as remote as possible from any ground where potatoes were raised in the preceding year. A great deal may also be accomplished, where there are no other potato patches in the immediate neighborhood, by killing every beetle found upon the vines in the spring, as fast as they emerge from the ground. By this means the evil is nipped in the bud, and a pretty effectual stop is put to the further propagation of the insect. But if there are potato patches near by, where no attention is paid to destroying the beetles, they will keep perpetually flying in upon you in spite of all you can do.

I have already stated that this insect cannot be driven as can the blister beetles, and we have to rely on other measures. I might occupy page after page in detailing the experiments that have been tried by myself and by others. But of all the mixtures recommended I can seriously recommend none. They are impracticable on a large scale, and require too frequent repetition to be efficient, as the beetles issue from the ground day after day. White hellebore, paris green, slaked lime, etc., etc., I have proved by experiment to be valueless, though the two first will kill, if thoroughly applied, a certain proportion of the larvæ, but will not affect the beetles; and even cresylic acid soap, which is the best wash of the kind, does not kill them all. Hot water affects the pests as fatally as any of these applications, and when I state that I have known the beetles to bore through three inches of hard unleached ashes, the folly of *their* application to the vines becomes at once apparent.

I, therefore, again impress upon my readers the importance of prevention by killing every beetle which first appears in the spring. There is no better way of doing this than by crushing them on the spot, and for this purpose a very simple pair of pincers may be constructed. At Figure 63 I represent a pair that were used last summer by S. H. Ford, of Rolling Prairie, Wisconsin, and which were kindly sent to me by L. L. Fairchild of the same place. Their construction is so simple that it needs no explanation, two pieces of wood, a screw, and two small strips of leather being the only things needed.

[Fig. 63.]



In parts of Iowa, the ravages of this insect were so serious in 1866, that a horse-machine was invented for their destruction by Mr. Benson, of Muscatine in that State. As this machine, or some improvement on it, may prove advantageous where potato-growing is carried on extensively, I subjoin an account of it.

"The cost of the machine was about thirty dollars. It consists of a frame-work, which moves astride the row of potatoes, on which is mounted longitudinally a reel somewhat like the one on McCormicks' old Reaper, which knocks the bugs off the plants into a box on one side. This box is of course open on the side next the row nearly down to the ground, but is some two feet high on the outside and at the ends. The reel works over the inner edge of the box, and the bugs are whipped off the vines pretty clean; and the most of them are thrown against the higher side of the box, which converges like a hopper over two four-inch longitudinal rollers at the bottom, between which the bugs are passed and crushed. These rollers are some three or four feet long.

"Those insects which are perched low down on the plants are frequently knocked on to the ground; but I think they would soon crawl up again; and repeating the operation at intervals would very greatly reduce their numbers, and lessen very much the labor of hand-picking, which I think would be advisable in conjunction with the use of the machine, in order to destroy the eggs and diminish the young brood, which is most destructive to the foliage of the plant."

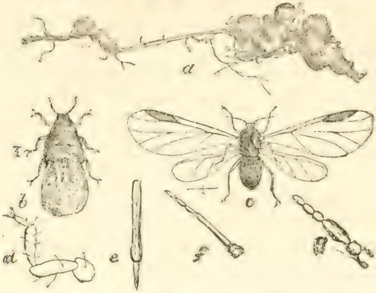
Much may be done by a proper choice of varieties, the Peach-blow having the same immunity from the attacks of this Colorado Potato-beetle, as from those of the Blister-beetles. I have known several instances where Neshannocks, raised side by side with Peach-blows, have been entirely destroyed, while the latter were untouched; and I therefore strongly recommend the planting of Peach-blows in those sections that have been visited by the beetle.

In conclusion let me give another word of caution. Our friends of the Eastern States will, doubtless, in the course of events, become sufficiently acquainted with this beetle. As already stated, it is now in Ohio, and will continue from year to year to spread eastward. Let us, of the West then, not hasten its introduction by our carelessness. Farmers are in the habit of sending insects through the mail to the editors of Eastern papers for identification. Wherever insects are thus sent, they should be thoroughly secured so as to prevent any possible escape. Specimens of this beetle were last year sent to the office of the *American Agriculturist*, in New York, packed in a very insecure manner. Had but a single impregnated female contrived to escape from the package, it might have been the means of prematurely introducing this mischievous pest into that State. A word to the wise is sufficient.

THE APPLE-ROOT PLANT-LOUSE—*Eriosoma [pemphigus] pyri*, Fitch.

(Homoptera, Aphidæ.)

[Fig. 64.]



The roots of the apple tree are very often found to rot, and thus cause the death of the tree. Of these rots there appear to be three distinct kinds. One kind is that popularly known as "rotten root" in Southern Illinois, and seems to be a simple decomposition of the vegetable tissue, analagous to the rotting of the root of a cabbage for instance. Its cause is not clearly understood, though it seems to be a consequence of certain conditions of the soil. The other rot was discovered the past summer by Dr. Hull, of Alton, Illinois, and is a fungoid growth, which, after covering the root with a thin layer of white fibrous substance, causes a sort of dry rot of the root, and which is common to both the pear and the apple. Some of the symptoms of this rot are: a rather earlier devolopment or maturity of the branches; an excess of fruit buds, and a shortening or thickening of some twigs. Specimens of the affected roots were brought to Dr. T. H. Hilgard, of St. Louis, for experiment, but all that he was able to ascertain was, that it enters the healthy wood in the shape of a brown stringy rot through the canals made by missing fibres.

In a paper read by Dr. Hull, before the Illinois State Horticultural Society, at its 13th annual meeting, a communication was quoted from Judge A. M. Brown, of Villa Ridge, in which the latter gave it as his firm belief that rotten apple tree roots were never caused by root-lice, but by this particular fungus. With due deference to Judge Brown's opinion, I have to differ with him most emphatically, for I am convinced that this Root louse *does cause the roots to rot*. I examined on the 15th of May last, hundreds of young apple trees on the nursery of Mr. J. M. Jordan, of St. Louis. Mr. J. had been greatly troubled with root-lice on his young apple stock during the year 1867, and had dug up and thrown thousands of young trees into a heap, by which means he expected to kill the lice and prevent their spreading onto new stock. He covered this heap with earth a foot deep, and had the gratification of finding that nearly all the lice had died by the next spring. Many rows of trees—mostly one year grafted—had been left in the ground, however, and on examining these, I found that wherever the previous year the lice had been numerous enough to cover and deform the whole root, there that root had invariably rotted. In many instances all trace of the knots and deformities which the lice cause, had disappeared, while, in some few instances they were yet traceable. In every case where rot had ensued the lice had entirely left, so that not a trace of them could be found. From these, and subsequent observations made during the summer, I conclude that the rot does not ensue till the roots have been completely deformed by the lice, and while on a young tree a colony of lice will multiply sufficiently to entirely cover it in a single season, and thus cause it to rot the next year; on larger trees they may be at work for years before this result is accomplished. This rot from root-lice may, I think, be distinguished from both the other kinds by its being more porous and soft, approximating the brown mould of a rotting log. The unusual swellings and knots caused by the lice, though hard originally, seem to loose their substance, and very frequently the finer roots, and almost always the fibrous roots waste entirely away.

The diagnosis of either of the first two kinds of rot must remain hidden, until our knowledge of these impalpable funguses shall have become more thorough, and until then no remedy can be suggested; but with the last kind, having traced it to its true cause, the means of prevention are at hand, and I will now give the history and description of the Apple-root Plant-louse for the most part as it appeared in the AMERICAN ENTOMOLOGIST for January, 1869:

For the last twenty years a Wooly Plant-louse has been known to infest the roots of the apple-tree, causing thereon swellings and deformations of almost every possible shape, and, when very numerous, killing the tree. In the more northerly parts of the Northern States this insect is comparatively rare, but in southerly latitudes it is exceedingly destructive in apple orchards. According to Dr. Hull, "it is one of the worst enemies against which our apple-trees have to contend, and is much more common in our region than is generally supposed." (*Agr. Rep, Mo., Append.*, p. 451.) As long ago as 1848, Mr. Fulton, of Chester county, Pennsylvania, found this root-louse and the knotty swellings produced by it to be so abundant on nursery-trees in his neighborhood, that thousands of young trees had to be thrown away, and it became difficult to supply the market.) Downing's *Horticulturist*, III, p. 394.) And in August, 1858, M. L. Dunlap (*Rural*) stated in the *Chicago Tribune*, that in an orchard near Alton "the Wooly Aphis infests the roots in immense numbers, and by sucking up the sap destroys the trees, which in its effect has much the appearance of dry rot."

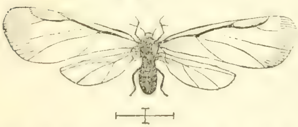
Although this insect usually confines itself to the roots of the tree, yet a few may occasionally be found on the suckers that spring up round the butt of the trunk, and even on the trunk and limbs, especially in places where a branch has been formerly amputated, and nature is closing up the old wound by a circle of new bark. Where it works upon the naked trunk, it often causes a mass of little granulations to sprout out, about the size of cabbage-seeds, thus producing on a small scale, the same effects that it does upon the roots. Wherever the insect works, small as it is, it may be easily recognized by the peculiar bluish-white cottony matter which it secretes from its body, and which is never met with in the case of the common Apple-tree Plant-louse that inhabits the leaves and the tips of the twigs.

Figure 64 at the head of this article, fully illustrates the Apple-root Plant-louse. A portion of a knotty root as it appears after the punctures of the lice is represented at *a*, the larva state at *b*, and the winged state at *c*; while *d* represents the leg, *e* the proboscis, *f* the antenna of the winged individual, and *g* that of the larva, all highly magnified. The young louse is of a deep flesh or pink color, and the proboscis extends the whole length of the body, while the older specimens have a deeper, purplish hue. Of the winged louse, I subjoin a more complete description.

ERIOSOMA PYRI, Fitch—Color black. Antennæ 2-5ths as long as the body, joints 1 and 2 almost confluent, short and robust; joint 3 fully ½ the entire length of the antennæ: joints 4—6 subequal, 5 a little the longest, 6 a little the shortest. Meso-thorax polished. Abdomen opaque with more or less pruinescence. Legs opaque black, immaculate. Wings hyaline; costal and subcostal veins robust and black; stigma pale brown, 2¾ to 3 times as long as wide, pointed at both ends, but more acutely so on the basal end, the vein bounding it behind robust and black. Discoidal veins and stigmal vein slender and black, the 3d or forked discoidal hyaline and subobsolete on its basal ⅓. Length to tip of closed wings 0.13—0.14 inch.

On comparing Figure 64 *c* with Figure 65, which represents a Plant-louse that inhabits a large gall on the Cottonwood, it will be observed at once that the veining of the front wing is very different. In Figure 64, *c*, the third branch-vein is very distinctly forked; in Figure 65 it is simple. Nor is this a mere accidental variation, but a peculiarity of the genus to which either insect belongs. (Fig. 64, *c*, genus *Eriosoma*; Fig. 65, genus *Pemphigus*). Now Dr. Fitch describes and names the Apple-root Plant-louse as belonging to the latter genus (*Pemphigus*); whereas winged specimens which both Mr. Walsh and myself obtained last October, at Duquoin, from apple roots and suckers swarming with larvæ; some which I received from St. Louis county, and others which Mr. Walsh bred from larvæ; all, without exception, belong to the former genus (*Eriosoma*). And moreover, Dr. Fitch's insect is described as being nearly twice as large as ours. How does this come about? We can only account for it in the following way: Dr. Fitch's winged specimens were but two in number, and they were found by him, the one living, the other dead, upon the roots of an infested young apple-tree, which had been brought him from an adjoining county. Hence he very naturally, but as we think erroneously, infer-

[Fig. 65.]

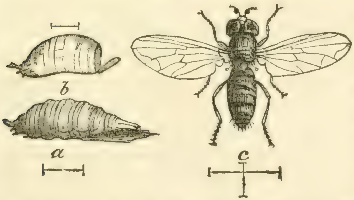


red that these two winged plant-lice belonged to the same species as the minute wingless larvæ with which the infested roots were swarming. The truth of the matter probably was, that the two winged plant-lice got upon the infested apple-root by accident, on their road from the nursery to Dr. Fitch's orchard. Indeed we can almost say with certainty to what species they belonged; for on comparing Dr. Fitch's very minute and elaborate description with the Beech-twig Plant-louse (*Pemphigus imbricator*, Fitch), which comes out in the winged state in the very same time of the year as he met with his two specimens, it agrees sufficiently well to apply to that species. If, on the other hand, we compare his description with our specimens, it not only disagrees generically, as already explained, but neither the size nor the markings will correspond at all.

We consider it, therefore, to be sufficiently certain that the Apple-root Plant-louse does not belong to the genus (*Pemphigus*), to which all subsequent authors, in deference to Dr. Fitch's authority, have hitherto referred it, but to the very distinct genus (*Eriosoma*) to which the notorious Wooly Plant-louse of Europe belongs (*Eriosoma lanigera*, Hausm.)

Natural Remedies.—From the enormous rate at which all Plant-lice multiply, it is plain that, if there were no check upon the increase of the Apple-root Plant-louse, it would in a few years' time sweep away whole orchards, especially in southern latitudes. Luckily for the fruit growers and fruit-lovers, there exist two at all events, and probably three such checks. The first is a very minute parasitic fly, which Prof. Haldeman figured and described in 1851 as infesting in the larva state his supposed Wooly Plant-louse.* The second is a footless maggot (Fig. 66 *a*) about one-half an inch long, and of a dirty yellow color. It is generally found more or less covered with mud, and with the woolly matter secreted by the lice, and is not by any means easily discerned. It changes in the fall to the pupa state (Fig. 66, *b*) from which, in the following spring, there emerges the perfect fly (Fig. 66, *c*) which may be known as the Root-louse Syrphus-fly. The following is the description of this fly, in its different stages, which appeared in the American Entomologist.

[Fig. 66.]



The Root-louse Syrphus-Fly. (*Pipiza radicum*, n. sp.) ♀ Shining brown black. *Head* clothed with short, rather sparse, white hairs, especially the lower part of the anterior orbits and the entire space below the antennæ. Mouth dark rufous. Antennæ compressed, with the joints proportioned as 2, 2, 5; joint 2 twice as wide as 1, and 3 twice as wide as 2; of a dull rufous color, edged above, narrowly on the inside, widely on the outside, with brown black. *Thorax* very finely rugoso-punctate, with some short sparse white hairs, especially laterally. *Abdomen* finely punctate,

* This fly belongs to the *Chalcis* family in the Order *Hymenoptera*, and was named *Eriophilus mali* by Prof. Haldeman. The figure and description will be found in the *Farm Journal* for 1851, pp. 130-1.

with longer white hairs, rufo-piceous above on the middle ⅓ of joint 1; venter with joint 1 piceous. *Legs* with all the 6 knees, and in the 4 front legs the entire tibia except a spot on the exterior middle, and also all the 6 tarsi except their extreme tips, and except in the hind legs the bassal ⅔ of the first tarsal joint, all dull pale rufous. *Wings* hyaline; veins black. Length ♀ 0.25 inch; alar expanse 0.48 inch.

One ♀; ♂ unknown. Bred May 23 from a single puparium found in the November preceding. On May 2 this puparium, which in the preceding autumn had been lightly covered with moist sand and deposited in a cellar, had crawled up out of the sand a distance of two inches, and attached itself to the stopper of the bottle in which it was inclosed. Upon being replaced under the moist sand, it was found two days afterwards to have again crawled about an inch up the side of the bottle. We have observed the same locomotive powers in the puparia of several other Syrphidous insects, though, so far as we are aware, this very anomalous faculty has not hitherto been commented on by authors.

We are indebted to Dr. LeBaron, of Geneva, Ills., who has paid special attention to the Order (*Diptera*) to which this insect belongs, for determining the genus to which it is properly referable. According to him, "the genus *Pipiza* differs from *Syrphus* in the absence of the prominence in the middle of the face, in the comparatively greater development of the posterior legs, and in the want of the little spurious longitudinal vein in the middle of the wing." "The only species discovered by Macquart," he adds, "is from Carolina, and very different from yours."

Larva.—Dull pale flesh-color, tinged with yellow. Attenuated and somewhat depressed anteriorly; more blunt posteriorly, the anal segment being furnished with an elevated tube, which is of a light polished brown at extremity. Wrinkled transversely, with a prominent fold at anterior and posterior edge of each segment. The larger segments well defined; the smaller ones less so. First segment thoroughly retractile, and sufficiently translucent when extended, to show the dark triple-jointed mouth. A few soft, fleshy spines, of the same color as the body, and especially distinct on anal segments. Generally covered and disguised by the soil which it inhabits. Length when not extended, 0.23 of an inch. Described from two specimens taken in 1866 and three in 1868.

Pupa.—Dull dirty yellow. Gradually formed by the contraction of the larva, during which time the wrinkles are obliterated, and it at last becomes quite smooth. Length 0.18.

I first found this larva in December, 1866, at Cobden, Ills., and have found it at several different times since, and though I failed to breed any to the perfect state, Mr. Walsh was more fortunate. Wonderful indeed must be that instinct, which enables the mother-fly to perceive which particular trees in an orchard have their roots swarming with lice, so as to know exactly where to deposit her eggs!

The third insect which preys upon these Root plant-lice, at least in Missouri, is a small species of ladybird, belonging to the genus *Scymnus.* The larva of this beetle is still more difficult to recognize among the lice, as it is covered on the back with little tufts of wooly matter, secreted from its own body. It is, when full grown, somewhat larger than the lice, and altogether more active, and is distinguished furthermore, by the wooly matter being of an even length and distributed over the back in transverse rows. Mr. J. F. Waters, of Springfield, Missouri, sent to me a number of the apple root-lice, with some of these little ladybird larvæ among them, which he erroneously supposed to be the old lice. In due time I bred the perfect beetle from them, and it proved to be a species which the French entomologist Mulsant, had described as *Scymnus cervicalis.* It is a very inconspicuous little beetle, about 0.05 of an inch long, and of a deep brown color, the thorax being of a lighter brown. From subsequent correspondence with Mr. Waters I learned that the lice upon which these little friends of ours were preying, were taken right from the surface of the ground, so that it is possible that this ladybird only attacks them when it can get at them above ground; though, judging from analogy, I strongly suspect it also seeks them out in their underground quarters.

ARTIFICIAL REMEDIES.—The best mode to get rid of the Apple root Plant-louse is to drench the roots of the infested tree with hot water. But to render this process effectual, the water must be applied in quantities large enough to penetrate to every part of the infested roots. There need be no fear of any injurious result from such an application of hot water; for it is a very general rule that vegetable organisms can, for a short time, stand a much higher temperature than animal organisms, without any injury to their tissues. In laying bare the roots for the better application of the water, a sharp eye should be kept for the friends above described, and when espied they should be tenderly laid aside till after the slaughter of the enemy. Mulching around the infested trees has been found, by Mr. E. A. Riehl and others, of Alton, Illinois, to have the effect of bringing the lice to the surface of the ground, where they can be more easily reached by the hot water.

THE WOOLY ELM-TREE LOUSE—*Eriosoma ulmi,* N. Sp.

(Homoptera Aphidæ.)

The White elm is subject to the attacks of a woolly plant-louse belonging to the very same genus as the preceding. This insect appears to be quite common in our State as well as in Illinois, for I have known several elm-trees on Van Buren street in the city of Chicago, to be killed by it, and every tree of this description, around the court house in St. Louis was more or less affected with it last summer. The lice congregate in clusters on the limbs and the trunks, and cause a knotty unnatural growth of the wood, somewhat similar to the knots produced on the roots of the apple-tree by the other species. They are mostly found sunk in between the crevices formed by these knots, and the punctures of their little beaks cause the sap to exude in the shape of little silvery globules, which may generally be found dispersed among the knots. The down or wooly matter is secreted by them from all parts of the body, but especially from the posterior part of the back. It is of an intense white color, and is secreted in such profusion that it usually covers and hides the lice, and when they are numerous, gives the limbs from a distance the appearance of being covered with snow. They make their appearance during the latter part of May, and by the latter part of June the winged individuals may be found mixed up with the larvæ and pupæ. I have experimentally found that a washing with a weak solution of cresylic acid soap will kill them all instantly, and they are thus easily exterminated. They are also preyed upon unmercifully by the larvæ of an undescribed species of Lacewing fly (*Chrysopa eriosoma* of my MS.).

ERIOSOMA ULMI, N. Sp.—Color dark blue. Length to tip of closed wings, exclusive of antennæ, 0.12. Wings hyaline, three times as long as wide, and more pointed at the ends than in *E. pyri*. Costal and subcostal veins, and that bounding the stigma behind, robust and black. Discoidal veins together with the 3d forked and stigmal veins, all slender and black, the forked vein being as distinct to its base as are the others, with the fork but ⅓ as long as the vein itself and curved in an opposite direction to the stigmal vein. Antennæ 6-jointed and of the same color as the body; joints 1, 2, 4, 5 and 6 of about equal length, joint 3 thrice as long as either. Legs of the same color as body.

The young lice are narrower and usually lighter colored than the mature individuals, varying from flesh or pink to various shades of blue and purple.

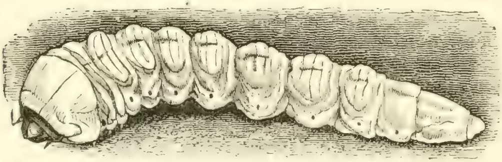
INSECTS INJURIOUS TO THE GRAPE-VINE.

The culture of the grape forms an important branch of Missouri horticulture. There is scarcely another State in the Union that has such natural advantages for the growing of this delicious fruit. While traveling up the Missouri river, I have been struck with the great similarity in the general character of the country to the celebrated Grape-growing districts of the Rhine, in Prussia. The Germans have also so thoroughly settled the country along the Missouri that the resemblance is made still more striking. As another evidence of the importance of this branch of horticulture in our State, the *American Grape Culturist*, the only periodical published in this country that is solely devoted to Grape-growing and wine-making, has just been started in St. Louis, by Mr. George Husmann. It becomes us then to know something of the insects injurious to the vine.

THE NEW GRAPE-ROOT BORER—*Orthosoma cylindricum*, (?) Fabr.

(Coleoptera, Prionidæ.)

[Fig. 67.]



The *ad interim* committees of the Illinois and Missouri State Horticultural Societies, while visiting the orchards and vineyards along the line of the Iron Mountain Railroad, discovered that sundry grape vines on Dr. C. W. Spaulding's place were dying; and on digging up such vines, the roots were found to be entirely hollowed out, and in many instances severed, by a worm which is faithfully represented at the head of this article—Figure 67. At about the same time, Mr. Walsh, of Rock Island, received an immense specimen from W. D. F. Lummis, of Makanda, Illinois, with the same account of its habits, and the following letters which I have since received relate to the same worm:

Mr. Riley—*Dear Sir:* Herewith please find a worm or grub, which has bothered my grape vines, it cuts the vine off about 3 or 4 inches under ground and takes out about an inch. Set vines last spring. Put stakes of oak, green.

Respectfully, &c.,

ALFRED BARTER.

Virgil City, Mo., August 21, 1868.

Prof. Riley, *State Entomologist:* I leave here for you a specimen of a worm which has proved very destructive in my vineyard this season having killed 24 vines, usually commencing at the bottom eye and eating the entire stem almost to the surface of the ground. I have dug up all the vines and in each case have found but one worm sometimes as deep as 18 inches below the surface. My vineyard was planted this spring on ground previously cultivated; has been thoroughly subsoiled and is well drained; the vines are Hartford Prolifics and Concords. Please send any information of value you may have relating to the above to Col. John H. Hogan, Pevely Station, I. M. R. R.

Very respectfully,

JOHN H. HOGAN.

September 3, 1868.

Mr. Riley *Dear Sir:* The Grape-vine borer has been quite destructive in our vineyard this season, having killed 15 vines. Except in two cases we found and dispatched him without mercy. We first noticed the effects of the borer about the latter part of July and frequently found them until the latter part of August. In some instances we found the root severed within ½ half an inch of the surface, while the borer was found at the bottom of the root. In others the root was eaten off from 5 to 8 inches below the surface. Only Concord vines have been affected, and only those that we obtained from a neighboring vineyard for planting last spring. Not one of our original vines have been destroyed, though we have 4 acres equally exposed to the attacks of this new destroyer. Any information that you may be able to give us upon this subject will be thankfully received.

Very respectfully,

SIMMONS & TILLSON.

Sulphur Springs, September 10, 1868.

Mr. D. C. Peebles, D. D. S., of St. Louis, also brought me a large Concord vine that had been entirely severed from the roots and killed by this worm, and I also received specimens about ¼ grown from T. W. Guy, of Glenwood.

The above letters convey a very good idea of the manner in which this borer works. It seems to have occurred in the Concord vines more generally than in those of any other variety, but I think that this may be attributed to the fact that more Concords are planted than any other kind, for as the following facts will show the borer is evidently a very general feeder. In the early part of June, 1867, Mr

O. B. Galusha, who was then with the *ad interim* committee visiting Southern Illinois, sent me a worm in all respects similar which was found boring into the root of an apple tree. I have also received Osage orange roots from Kansas which were being bored by the same fellow, and he is evidently partial to rotten oak stumps for not only have several persons who are well able to judge, assured me that they have found him in such stumps, but Mr. A. Bolter, of Chicago, also found it in such stumps in Kentucky, and sent me the specimens for identification. At the meeting of our State Society, at Columbia, Mr. J. N. Stuart even avowed that he had found it partly grown, not only in seedling apples but in the roots of corn stalks, while Chas. Connon, of Webster, assures me that he has found it in the heart of felled hickory, and I ascertained that he was perfectly capable of distinguishing it from the common borer (*Cerasphorus cinctus*, Drury), which infests hickory when felled, and which causes what is known as "powder post," he being quite familiar with this last named insect. There are several large beetles in the West which must have larvæ very similar in appearance to this, and it is not at all unlikely that different insects have here been confounded, but the figure at the head of this article, with the following description of this Grape-Root borer, will enable any one to recognize it in the future.

LARVA OF ORTHOSOMA CYLINDRICUM, (?) Fabr.—Average length when full grown, 3 inches. Color pale yellowish white, partly translucent, with glaucous and bluish shadings, and a distinct dorsal line of the last color. Segment 1 rather horny, rather longer than 2, 3 and 4 together, broadening posteriorly, slightly shargreened and whiter than the rest of the body, with a rust-colored mark anteriorly. Segments 2 and 3 shortest and broadest, the body tapering thence gradually to extremity, though there is usually a lateral ridge on segment 12 which dilates it rather more than the segments immediately preceding it. This segment 12 is also the longest, the terminal one being quite small and divided into three nearly equal lobes. A swelled hump crossed with two impressed transverse lines, on segments 4, 5, 6, 7, 8, 9 and 10. Stigmata rust-colored, 9 in number, the first and largest being placed on a fold in the suture between segments 1 and 2. Head brown, verging to black on anterior edge. Mandibles large, strong, black, with one blunt rounded tooth, giving them a somewhat triangular appearance; antennæ 3-jointed and brown, especially at tip; labrum fulvous, fuzzy and with a brown base; maxillary palpi 4-jointed, the basal joint much swollen, the terminal joint brown, and a ring of the same color at sutures of the other joints; labial palpi 3-jointed, the basal joint also swollen, and the terminal joint and sutures of the others brown. Six rudimentary 2-jointed fuscous feet as shown at Figure 68. Venter tubercled as on the back, these tubercles being especially prominent on segments 6, 7, 8 and 9, where they recall prolegs. The young larva differs only in lacking the rust-colored mark on segment 1.

[Fig. 68.]

Now, to what insect does this borer belong? It is manifestly the larva of some long-horned beetle of the family PRIONIDÆ, but of what particular species cannot be positively stated till the beetle is reared from grape-root-boring larvæ. Before another year shall have passed away, I hope to definitely determine this point, but meanwhile, I have every confidence that it will produce the Cylindrical Orthosoma (*Or-*

[Fig. 69.]

thosoma cylindricum, Fabr.), a large flattened, long-horned light bay-colored beetle which is common throughout the country and especially in the Mississippi valley, and which is represented of the natural size at Figure 69. True, according to Westwood, the larvæ of the PRIONIDÆ have the second segment enlarged and broadened, while the closely allied family CERAMBYCIDÆ, has the first segment thus enlarged as in our insect; but from a larva resembling ours in every respect so far as his description goes, and which he found in September, 1867, in decaying pine wood, Mr. Walsh actually bred, about the last of June, 1868, the Cylindrical Orthosoma. The only accounts on record which pretend to give the natural history of this beetle, are by Dr. Fitch and S. S. Rathvon, that of the former in his 4th Report, § 239, and that of the latter in the Agricultural Reportfor 1861, pp. 611–612. Dr. Fitch describes the larva, which he supposed belonged to this beetle, but which he did not breed, as occurring in pine trees, and as having the first ring longest and the second broadest; while Mr. Rathvon figures it with the first ring infinitely shorter than the second, but confesses that the drawing was made from memory, and he doubtless trusted to the authority of Westwood. Furthermore Monsieur E. Perris has figured at Plate 6, Figure 362, of the "Annales de la Société Entomologique de France," for 1856, the larva of *Prionus obscurus*, Oliv. which bores into the pine and which very closely resembles our larva, the first and not the second segment being enlarged.

Until the past summer nothing had been published about the attacks of this insect on Grape roots, and yet upon inquiry I find that it has been known for several years. Mr. Spaulding informs me that the first that was seen of it in his neighborhood was in 1866, when his man found an enormous one in a wild vine which he was about to graft; but Mr. Geo. Husmann, of Hermann, has been acquainted with it since 1850, and has known it to occur around Hermann since 1854. Indeed Mr. Husmann informs me that he has never observed the old Grape-vine Borer which has 16 legs and which produces a moth (*Ægeria polistiformis*, Harris) but that in speaking of the Grape-root Borer he has always referred to this species. Mr. J. H. Tice found it in apple roots in 1860 on the place of James Sappington of St. Louis, while the following item by A. J. H., of Vineland, N. J., which appeared in the January (1869) number of the *Gardener's Monthly*, would indicate that it has the same habit all over the country:

"On page 354 October number of *Agriculturist*, reference is made to a " vine borer " in Missouri that cuts off vines below the surface. It is also mentioned and partially described in the last *Gardener's*

Monthly. This "borer" is an old friend (?) of mine. It is found principally in old rotten oak stumps; I hardly ever dig one out without finding several of these worms. They are about two inches long, tapering from head to tail, white bodies and black heads. I lose on an average about 50 vines and dwarf pears annually by these little villains; probably twice as many pears as vines. I have had several apple trees cut off by them, and one standard pear. The tree roots seem often to be eaten entirely up, but the vine roots are only cut through as if they had obstructed the line of travel.

This is no new insect, but will I think probably be found troublesome whenever dwarf pears and vines are planted among decayed oak stumps."

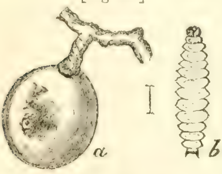
Remedies.—Little can be done in the way of extirpating these underground borers, when, as in the present instance, their presence is only indicated by the approaching death of the vine. Still, every vineyardist should make it a rule to search for them wherever they find vines suddenly dying from any cause unknown to them, and upon finding such a borer should at once put an end to his existence. The beetle which may frequently be found during the summer months, should also be ruthlessly sacrificed wherever met with. I should also advise not to plant a vineyard on land covered with old oak stumps, and not to use oak stakes where those made of cedar can be had as conveniently.

THE GRAPE CURCULIO—*Cœliodes inæqualis*, Say.

(Celeoptera, Curculionidæ.)

The larva of this Curculio infests the grapes during the months of June and July, causing a little black hole in the skin, and usually a

[Fig. 70.]



disfigurement and discoloration of the berry, immediately around it as in Figure 70, *a*. The larva (Fig. 70, *b*) is whitish as long as the berry is green, but generally partakes of the color of the berry as it matures. It is footless and like the larvæ of all snout-beetles is incapable of spinning a web. In 1867 I found this insect quite common in Southern Illinois, and as will be seen from the excellent account of it given by Mr. Walsh in his first report, it was very common in the States of Illinois, Ohio and Kentucky, and it also occurred in our own State, as I am informed by Mr. Peabody. From the middle to the last of July, this larva leaves the berry and buries itself a few inches in the ground. Here it changes to a pupa within a small, smooth earthen cavity, and by the beginning of September the above named beetle issues from the ground, and doubtless passes the winter in the beetle state, ready to puncture the grapes again the following May or June. This beetle is

[Fig. 71.]

small and inconspicuous, being of a black color with a grayish tint. It is represented enlarged at Figure 71, the hair line underneath showing the natural size. It is distinguished from all other curculios that are known to attack our fruits by having a rectangular thorn or tooth on the upper and outer edge of the four front shanks (*tibiæ*) as shown at Figure 72; this character being peculiar to the genus (*Cœliodes*) to which it belongs.

[Fig. 72.]

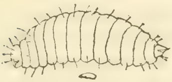
Strange as it may seem, in 1868 there seems to have been an almost entire immunity from this Grape curculio, for I have neither met with it in a single instance, nor heard of its occurrence. No doubt this immunity has been caused principally by parasites, for I failed entirely to breed the perfect Curculio in 1867, on account of some small Ichneumon which killed the larva as soon as the latter had entered the earth, and spun for itself a tough silken cocoon in the place where the Curculio larva, if unmolested, would have undergone its transformations. It is thus that Nature works; "eat and be eaten, kill and be killed," is one of her universal laws, and we can never say with surety that because a particular insect is numerous one year, therefore it will be so the next!

THE GRAPE-SEED CURCULIO.

(Coleoptera, Curculionidæ.)

A minute maggot was discovered last August infesting the seeds of the Grape in certain parts of Canada, by Mr. Wm. Saunders, of London. It causes the berries to shrivel up and utterly ruins them. Specimens which had been received from Canada, were sent to me by my friend A. S. Fuller, of New Jersey, and the annexed Figure 73

[Fig. 73.]



shows a highly magnified view of the maggot, its natural size being represented underneath. The head is of the same translucent, milk-white color as the body, but the jaws, which are finely pointed, are light brown, and there is a patch of brown at their base. It has exactly thirteen segments exclusive of the head, and every segment has a few white, fleshy hairs, these hairs being thickest near the head and longest on the under part of the first three segments, thus imitating feet, as is often the case with footless larvæ of this character.

It is evidently the larva of some curculio, and though it is not yet known to occur in the States, I append the following account of it from Mr. Saunders himself, for the benefit of our Grape-growers:*

* This account is taken from a paper published by Mr. Saunders in the "Report of the Commissioner of Agriculture and Arts of the Province of Ontario," for 1868—pp. 203–5.

"On the 20th of August last we observed that many of the berries in the bunches of a Clinton vine under our care were shriveling up. On opening the grapes, we observed that most of the smaller berries —that is those which had shriveled earliest—contained only one seed, and that of an unusually large size. Some of the larger shriveled grapes contained two seeds, much swollen, each having a dark spot somewhere on their surface. On cutting the seeds carefully open, the kernel was found almost entirely consumed, and the cavity occupied by a small milk-white footless grub with a pair of brown hooked mandibles, a smooth and glossy skin with a few very fine short white hairs. When at rest it is nearly oval in form, but when in motion its body is elongated, varying in length from one-fifteenth to one-twelfth of an inch. * * *

"The Clinton vine on which this pest was first discovered suffered considerably, fully ten per cent. of the crop was lost from the shriveling of affected berries. At first we supposed that the work of the insect was confined to berries of this appearance, and that by destroying these the destruction of the crop of insects for the season would be complete, but further examination showed that many of the ripe berries contained affected seeds. The proportion thus affected on the vine referred to was about ten or eleven per cent. Within a few feet of this vine an Isabella was fruiting; on this there were no shriveled berries, but about three per cent. of those which had ripened were injured. About the same distance in another direction was a Hartford Prolific, and about ten feet further off a Concord, both of which fruited well. On neither af these were there any shriveled berries, nor could we find any affected seeds among those which had ripened. The fruit of a Delaware, about fifty feet distant from the Clinton, was also examined without discovering any traces of the insect.

"About the middle of September we visited the grounds of Mr. Charles Arnold, of Paris, and there we found that this insect had prevailed to a greater extent than it had with ourselves, affecting the Clinton, Delaware, one of Rogers' Hybrids, and also Mr. Arnold's new seedlings. In Hamilton, in the garden of Mr. W. H. Mills, we found an affected seed in a berry of Rogers' No. 4. On the 24th of September we visited the vineyard of the Vine Growers' Association at Cooksville, but could not find any traces of the insect there. Thus far its depredations are most apparent about London and Paris, but probably further examination will show that it is widely distributed.

"Where any shriveled berries are found their seeds should be carefully opened and examined, as it is important to know how far the insect prevails. The affected berries are usually swollen, somewhat soft, and have a dark spot somewhere on their surface; any of this character observed among the ripe berries should also be examined.

"In the case of the shriveled berries, where one seed only is affected, the others are dwarfed and imperfect; and where two large seeds are found they are both occupied. Where one seed only is affected and the other remains healthy, the one normal seed carries the berry through in an apparently healthy state to ripeness. As far as our experience goes the Clinton and its allies with thin skins are more liable to attack than berries with thicker skins, such as Hartford Prolific and Concord.

THE GRAPE-CANE GALL-CURCULIO, *Madarus vitis*, New Species

(Coleoptera, Curculionidæ.)

The canes of the Concord vine are frequently found to have galls on the last year's growth, in the shape of an elongated knot or swelling which is generally situated immediately above or below a joint. This gall was formed the previous fall while the tender cane was growing, and has almost invariably a longitudinal slit or depression on one side, dividing that side into two cheeks, which generally have a rosy tint. The gall is caused by a little footless, white cylindrical larva which measures 0.28 of an inch, and has a yellowish head, and somewhat darker tawny jaws. It is minutely wrinkled transversely, and sparsely covered with minute white bristles; the three segments next to the head being prominently swollen underneath and the bristles attached to them look very much like legs, and doubtless to some extent perform the functions of legs. This larva indeed bears a very close general resemblance to that of the Potato Stalk-weevil, illustrated at page 93, Figure 37 *a*, and when taken out of its gall immediately curls up as in that figure. During the latter part of June this larva transforms within the cane to a pupa, also greatly resembling that figured at *b*, on page 93, with the exception that it is much smaller, and that the wings and legs reach down three-fourths the length of the body instead of but one-half as in that species. Two weeks after it has thus transformed it becomes a beetle belonging to

[Fig. 74.]

the great Curculio family. Before this insect had ever been bred to the perfect state I predicted that it would produce a Curculio, as may be seen by referring to page 117 of the Transactions of the Illinois State Horticultural Society for 1867. This beetle is represented enlarged at Figure 74, its natural length being 0.10. It is of a uniform light yellowish-brown without any markings whatever. It is closely allied to the Potato Stalk-weevil, but belongs to the genus *Madarus* which differs from *Baridius* in the peculiar undulating appearance of the wing-cases, and more especially in their being highly polished, the word *Madarus* meaning glossy or polished. This little

Curculio was considered a new species by Dr. Le Conte, in 1861, and as it has not, so far as I am aware, been described since that time, I subjoin a more complete description of it:

MADARUS VITIS, N. Sp.—Length, exclusive of rostrum 0.10. Color uniformly rufous, without maculations, the eyes alone being darker. Highly polished; rostrum arcuated, stout and about as long as thorax; thorax and body with extremely minute and distant punctures, anterior margin of thorax abruptly narrowed, especially laterally, into a collar; elytra slightly undulate, with 4 distinct elevations, one on the extreme outer margin close to the thorax, and one on the middle of each, near the extremity.

As an illustration of the great similarity in the habits of insects belonging to the same genus, I will state that there is a small black Curculio, belonging to the genus *Madarus* and differing from this Grape-cane Gall-curculio in no other respect but in color, whose larva lives in a somewhat similar gall found on the common creeper (*Ampelopsis quinquefolia*) which is very closely related to the vine. This black species is also undescribed and is marked *Madarus ampelopsis* in Mr. Walsh's collection.

I think it highly probable that the gall of the Grape-cane Curculio is caused more by the punctures which the female beetle makes in depositing her egg, than by the irritations of the larva; for I have found the larva where it had burrowed two and three inches up the cane, away from the gall, without its having caused a corresponding swelling; though this has always been in the one-year-old cane.

REMEDY.—If these gall-bearing canes are cut off and burned during the winter there need be little fear of this insect's work, the more especially as it is not secure from parasites, even in its snug retreat, for I have bred a species of *Chalcis* fly from the galls, which had evidently destroyed the true gall-maker.

THE GRAPE-VINE FIDIA—*Fidia viticida*, Walsh.

(Coleoptera, Chrysomelidæ.)

One of the worst foes to the grape-vine that we have in Missouri

[Fig. 75.]

is the Grape-vine Fidia which is represented in the annexed Figure 75. It is of a chestnut-brown color, and is densly covered with short and dense whitish hairs which give it a hoary appearance. I have found it very thick in most of the vineyards which I visited, and it is almost universally miscalled the "Rose-bug," which is, however, a very different insect. The Grape-vine Fidia was first described by Mr. Walsh in the May, 1867, number of the *Practical Entomologist*. It is found in the woods on the wild grape-vine and also on the leaves of the *Cercis Canadensis*; but of the tame vines it seems to prefer the Norton's Virginia and Concord. It makes its appearance during the month of June, and by the end of July has generally disappeared, from which fact we may infer that there is but one brood each year. The manner in which it injures the vine is by cutting straight elongated holes of about ⅛ inch in diameter in the leaves, and when numerous it so riddles the leaves as to reduce them to mere shreds. The preparatory stages of this beetle are not yet known.

REMEDIES.—Luckily this beetle has the same precautionary habit of dropping to the ground, upon the slightest disturbance, as has the Plum curculio, and this habit enables us readily to keep it in check. The most efficient way of doing this is by the aid of chickens. Mr. Peschell, of Hermann, on whose vines this beetle had been exceedingly numerous, raised a large brood of chickens in 1867, and had them so well trained that all he had to do was to start them in the vineyard with a boy in front to shake the vines, and he himself behind the chicks. They picked up every beetle which fell to the ground, and in this manner he kept his vines so clean that he could scarcely find a single beetle in 1868.

THE GRAPE CODLING, *Penthina vitivorana*, Packard.—Plate 2, Figs. 29 and 30.

(Lepidoptera, Tortricidæ.)

Although the preceding insect has been so scarce in 1868, yet the Grape has been worked upon in a somewhat similar manner, and even to a greater extent, by the insect now under consideration. Indeed there is very little doubt that Mr. Walsh, not being acquainted with this insect, confounded its work with that of the Grape-curculio, in some of the instances, of the damage done by this last, which are quoted by him in his report, and this is especially the case in the instance of Mr. M. C. Read of Hudson, Ohio.

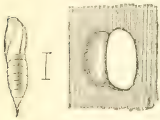
I first received this insect, with an account of its workings, from Huron Burt, of Williamsburg, and subsequently during the month of July, found it universal in the vineyards along the lines of the Pacific and Iron Mountain Railroads. It was found equally common around Alton in Illinois, while Dr. Hull informs me that it ruined 50 per cent. of the grapes around Cleveland, Ohio, the Concord and Ives Seedling being the only varieties which appeared to resist its attacks. It also occurs in Pennsylvania, judging from articles which appeared in the November and December numbers of the *Practical Farmer*. In these numbers my esteemed correspondent, Mr. S. S. Rathvon, of Lancaster, Pennsylvania, gives an account, with description, of some worms which were sent to him by the editors, answering in every respect to this Grape codling. Concluding, from its similarity to the common Apple-worm, that the insect belonged to the genus *Carpocapsa*, he proposed for it the name of *Carpocapsa vitisella*, without having bred the parent moth. In the June number of the *American*

Naturalist (p. 220) is quoted an account of it by Mr. M. C. Read, of Hudson, Ohio, who says that it is "already so abundant there that it is necessary to examine every bunch of ripe grapes, and clip out the infested berries before sending them to the table."

The larva of this Grape-codling may at once be distinguished from that of the Grape curculio, by its having 6 scaly legs near the head, 8 fleshy legs in the middle, and 2 at the extremity of the body, and by spinning a fine web, by which it lets itself drop whenever handled. It is also larger, of a darker color, and bears a very close resemblance to that of the Strawberry leaf-roller, to be hereafter figured and described.

Its presence is soon indicated by a reddish-brown color on that side of the yet green grape which it enters. On opening the grape, a winding channel is seen in the pulp, and a minute white worm with a dark head is seen at the end of the channel. It continues to feed upon the pulp of the fruit, and when it reaches the seeds, eats out their interior. As it matures it becomes darker, being either of an olive-green or dark brown color, with a honey-yellow head, and if one grape is not sufficient it fastens the already ruined grape to an adjoining one by means of silken threads, and proceeds to burrow in it as it did in the first. When full grown it leaves the grape and forms its cocoon on the leaves of the vine. This operation is performed in a manner essentially characteristic: the worm cuts out a clean oval flap, leaving it hinged on one side, and, rolling this flap over, fastens it to the leaf, and thus forms for itself a cozy little house which it lines on the inside with silk. One of these cocoons is represented at Figure 76, *b*, and though the cut is sometimes less regular than shown in the figure, and I have had them spin up in a silk handkerchief without making any cut at all, it is undoubtedly the normal habit of the insect to make just such a cocoon as represented. In this cocoon, within two days, it changes to a chrysalis, such as is represented at Figure 76, *a*, of a honey-yellow color with a green shade on the abdomen; and in about ten days more the moth makes its escape, the chrysalis having first pushed itself almost entirely out of the cocoon. The moth is of a slaty-brown color with corky-yellow markings, and is represented enlarged at Plate 2, Figure 29, and of the natural size at Figure 30.

[Fig. 76.]



a *b*

Specimens of this moth were sent by Mr. Walsh to the English Lepidopterist, H. T. Stainton, who could not refer it to any known genus; but Dr. Packard, of Salem, Massachusetts, refers it to *Penthina* a genus very closely allied to *Carpocapsa*, to which our Apple Codling moth belongs. He has also kindly furnished me with advanced sheets of Part V of the "Guide to the Study of Insects," in which (p. 336) he describes and figures it under the name of *Penthina vitivorana*. The description is quite brief, however, and the figure not good, and I therefore subjoin a more detailed description of it in its different stages:

PENTHINA* VITIVORANA, Packard—*Larva.*—Average length 0.35. Largest on segments 10 and 11, tapering thence gradually to the head and suddenly to anus. Color either dark shiny olive-green, glaucous, or brownish. Head and cervical shield honey-yellow, the latter with a darker posterior margin. Piliferous spots scarcely distinguishable. Described from 10 specimens.

Crysalis—0.18—0.20 long. Of normal form. Quite variable in color. Usually of a light honey-yellow, with a green shade on the abdomen, and black eyes, but sometimes entirely dark-green, with light eyes. The chrysalis skin, after the moth has left, is always deep honey-yellow, with the green abdominal mark distinct.

Perfect insect—Average length 0.17; alar expanse 0.37. Head, thorax, palpi and basal half of antennæ fulvous Terminal half of antennæ darker. Legs fulvous, becoming darker on tarsi. Ground-color of fore wings pale slate-blue, with a slight metallic lustre, which becomes lighter and somewhat silvery interiorly and posteriorly. A dark rich-brown band, with a light, somewhat silvery annulation proceeds from the middle of the costa towards the inner margin, becoming paler interiorly; its basal margin being indistinct, but running almost straight across the wing, its outer margin well defined, curving to a rounded point which reaches to the middle of the outer third of the wing and thence running obliquely inwards, nearly to the middle of the inner margin. Beyond this middle band is a large, deep brown, somewhat oval spot, also lighter below than above, and with a pale annulation, which is broken on the outer side above, allowing the spot to extend to the margin of the wing. Above this large spot, at the apex, is a small perfectly round dark spot, with a bright annulation inclining to orange color. The space enclosed by the middle band, and these two spots just described, is brown above, with usually four lighter fulvous costal marks quite distinct, each mark divided at costa by a slight touch of brown. Another somewhat triangular brown spot, with a light annulation above, runs from the posterior angle up between the middle band and large oval spot. The blue space from the middle band to the base of wing is generally brownish near the base, with a brown line across the middle from costa to inner margin, and with two other costal brown marks. The fringes partake of the ground-color. Hind wings slate-brown, darkest near the margins; fringes same color. Body brownish with frequently a clear green tint. The male differs principally in its somewhat smaller size, and especially in the smaller size of the abdomen. Individuals vary greatly.

Described from 5 ♀ and 2 ♂ specimens, all well preserved and fresh.

REMEDIES.—This insect threatens to become a grievous pest unless checked by some unforseen means, as was the case with the Grape curculio. Luckily, there is at least one parasite which attacks it, in the shape of a yellowish, footless maggot, with a green tint and 14 segments. I obtained such maggots from two of the caterpillars, one having crawled out of its host before, and the other after he had spun up. Absence from home prevented my breeding this parasite, but it would doubtless have produced some 4-winged fly belonging to the *Chalcis* family (see Pl. 2, Figs. 6 and 9). According to Mr. Read, the first brood of caterpillars feed on the leaves, appearing in May (in Ohio) or as soon as the leaves are grown. The worms which appear in our grapes in July are, therefore, the second brood, and there is doubtless a third brood, for Mr. Rathvon received them in October, and I have taken the worm out of a grape as late as the 22d of September. The broods, in all probability, run into one another and the last passes the winter within the cocoon, either in the larva or pupa state. They should, therefore, be searched for early in the season on the leaves. The second brood of worms, or those which infest grapes, can easily be espied and destroyed in a healthy vineyard; but where a vineyard

*Heinemann and Lederer unite the genus *Penthina* wrth *Grapholitha*, under the latter name, and I believe Mr. C. T. Robinson, of New York, follows them in this respect.

is affected with what Prof. Turner, of Jacksonville, Illinois, designates as the "American Grape rot," the grape attacked by the Codling are not so easily distinguished, as they bear a close resemblance to the rotting ones. Care should be taken in gathering the infested grapes for the worm being very active wriggles away and easily escapes.

THE EIGHT-SPOTTED FORESTER, *Alypia octomaculata*, Fabr. Pl. 1, Figs. 18 and 19.

(Lepidoptera, Zygænidæ.)

At Plate 1, Figure 19, is represented a caterpillar which has been sent to me by several correspondents with the statement that it was found on their grape vines, and during the month of May, I found the same caterpillar on the vines of Mr. T. R. Skinner, of Cheltenham, and of Mr. Peabody, of Sulphur Springs. It grows to the length of $1\frac{1}{4}$ inches, and is transversely striped with bluish-white and black, about 4 white and 4 black lines on each segment, with two small black spots in the middle light band on the back. The head and a shield on the first segment are shiny gamboge-yellow, with black dots, and on the 11th segment there is an orange elevation, not shiny and with two black spots in it. From similar caterpillars, which were taken from grape vines in 1865 I bred in the spring of 1866 the moth figured at Plate 1, Figure 18, known as the Eight Spotted Forester (*Alypia octomaculata*, Fabr.) It is recognized at once by its conspicuous markings, being of a black color with orange shanks, each of the fore wings with two large light yellow spots and each of the hind wings with two white spots. The caterpillars leave the vines during the month of June, and descend into the earth where they form for themselves slight cocoons of earth in which they remain through the winter and from which the moth escapes the following April.

It is not probable that this caterpillar which may be called the Blue Caterpillar of the vine, will ever become exceedingly numerous, for it has not been known to become so in the past, and this hasty sketch of its history is given principally for the gratification of the intelligent grape-grower who takes pleasure in thoroughly understanding and knowing, in all their different guises, the creatures he has to deal with.

There are two other caterpillars very much resembling this, which also feed on the vine; but they produce very different looking moths, the one known as *Eudryas grata*, Fabr., and the other as *Eudryas unio*, Hübner. Dr. Fitch in his 3d Report §123 states that the larva of *E. grata* differs only from that of *A. octomaculata* in lacking a white spot on each side of every segment, and in being slightly humped at its hind end. The specimen from which my figure was made may prove to be *E. grata*, for it had no such white spots and *was* humped; but it differs essentially from the most excellent description of this last larva which A. S. Packard, Jr., has given in his "notes on the family Zygænidæ, pp. 27–29, and sufficiently resembles those from which I actually bred the 8-spotted Forester.

THE GRAPE-VINE PLUME, *Pterophorus periscelidactylus*, Fitch. Plate 2, Figs. 15 and 16.

(Lepidoptera, Alucitidæ.)

During the latter part of May and beginning of June, the leaves of the grape-vine may often be seen drawn together by silken threads and in the retreat thus made will be found a small hairy caterpillar which feeds on the tender leaves of the vine. This caterpillar grows to the length of about half an inch; the color of the body is very pale green and has four elevated white spots and two still smaller dots on every segment, from which spring stiff white hairs in all directions.

This caterpillar was quite common last summer in many sections of the State. It was first named by Dr. Fitch, who found it on the vine in the State of New York. A number which I brought home changed to chrysalids during the first days of June, and the moths were produced from them in about 8 days afterwards. The worm first spins a few threads of silk to the underside of a leaf, or other object, and the chrysalis attaches the lower part of the terminal segments to them, and hangs with the tail somewhat curved, at a slant of 40° from the object, as represented at Plate 2, Figure 16. This chrysalis measures 0.35—0.40 in length, is of a light-green color and of peculiar form. It is ridged, with remnants of the tubercles of the caterpillar. It is angular and cut off slantingly and bluntly at the head, but is characterised principally by two sharp and angulated projections from the middle of the back, and which are enlarged under the figure 16, in Plate 2.*

The moth (Pl. 2, Fig. 15) is of a tawny yellow color, the wings marked with white and with a darker shade. The caterpillars disappear very suddenly, for the chrysalis is so small and so nearly the color of the leaf, that it would be seldom noticed, even it were not so well hidden. There are probably two broods in the year, though I failed to find any trace of them after the first had disappeared.

All the moths of the family (ALUCITIDÆ) to which this belongs have very appopriately received the name of Plumes. In the genus *Pterophorus* the fore wings are divided into two and the hind

*Dr. Fitch has given a most excellent and full description of this chrysalis in his 1st Report pp. 140–141.

wings into three lobes, and to show how very different insects may be in the larva state, both in habit and appearance, even when they belong to the same genus and greatly resemble each other in the perfect state, I have represented at Plate 2, Figure 13, another Plume, which I shall presently describe as the Thistle Plume.

Remedies.—Whenever they become numerous, as they did last summer, the only remedy is hand-picking.

THE TREE-CRICKET—*Œcanthus niveus*, Harris.

(Orthoptera, Achetidæ.)

This insect is represented in the annexed cuts, Figure 77 showing the male, and Figure 78 the female. The general color is a delicate greenish, semi-transparent white, though some specimens have a blackish shade. From the fact that it is known to devour plant-lice and likewise the eggs of some moths, I was formerly in doubts whether it should be considered friend or foe, but the experience of the past year settles the matter definitely, for it has proved very destructive to the vine. The female deposits her eggs in grape canes, raspberry and blackberry canes, in the twigs of the peach, White willow, and a variety of other trees. In depositing, she makes a straight, longitudinal, contiguous row of punctures, each puncture about the size of that which would be made by an ordinary pin. From each of these holes, a narrow, yellowish, elongate egg, runs slantingly across the pith. The twigs or canes thus punctured almost invariably die above the punctured part, and the injury thus caused to vines is sometimes considerable.

[Fig. 77.]

[Fig. 78.]

But by far the worst habit of the Tree-cricket is that of severing grapes from the bunches just as they are beginning to ripen, and it sometimes cuts off an entire bunch, or so thoroughly excoriates the stem that it fails to ripen its berries. I have seen the ground under some vines covered with grapes which had been thus severed, but should never have accused the Tree-cricket, had I not found it in the very act, and received specimens with accounts of this same habit, both from Mr. B. L. Kingsbury, of Alton, Illinois, and from J. H. Tice, of St. Louis. This cricket is aided in this destructive work by another species which has the same habit, namely the Jumping Tree-cricket (*Orocharis saltator*, Uhler.) This last insect is more robustly built than the former, and is at once distinguished by its uniform light-brown color, and I have good reason to believe that it deposits its eggs in the grape-vine in a row of punctures, each of which is about one-third of an inch apart, and each of which leads to from ten to twelve narrow eggs, about a tenth of an inch long, and deposited on either side of the puncture, length-wise in the pith.

REMEDY.—The crickets themselves should be crushed whenever met with, while the vineyardist should make a business of searching in the winter time for all punctured twigs, and by burning them, prevent their increase in future.

THE RASPBERRY GEOMETER, *Aplodes rubivora*, N. Sp.—Pl. 2, Figure 25.

(Lepidoptera Geometridæ.)

The lovers of those most exquisite fruits, the Raspberry and the Blackberry are often greatly disgusted by the discovery of the fact that instead of the delicious berry which they expected to enjoy, they are munching the small caterpillar now under consideration. This caterpillar was quite numerous last summer on both the above named fruits at South Pass, Illinois. It has the peculiar faculty of thoroughly disguising itself with pieces of dried berry, seed, pollen, and other *débris* of the fruit, which it sticks to a series of prickles with which it is furnished. Add to this disguise the habit which it has of looping itself into a small ball, and it almost defies detection. It is most numerous during the months of June and July. Through the kindness of Mr. T. A. E. Holcomb, of South Pass, I was enabled to breed this insect to the perfect state. From two specimens of the larvæ which he sent me, I bred from one, July 9th, the little moth which is illustrated at Plate 2, Figure 25, the other being infested with a parasite which formed a tough cocoon, very much like that of a parasitic fly (*Campoplex fugitivus*, Say), which I have bred from milkweed feeding larvæ of *Euchætus egle*, Harris. This little moth is of a delicate light grass-green color, with two paler lines running across both wings as in the figure. It belongs to the genus *Aplodes*, and as I am informed by Dr. Packard, comes very near to *glaucaria* Guénée, and has not hitherto been described. In the proceedings of the Boston Society of Natural History (Vol. IX, pp. 300-2) Mr. Walsh has described an oak-feeding Geometer which closely resembles this, both in the larva and perfect states. He erected the new genus *Hipparchiscus*, for it and gave it the specific name *venustus*. It is a much larger insect, and differs in sundry respects from the species under consideration, though the moth is of the same color and somewhat similarly marked.

APLODES RUBIVORA, N. Sp. —*Larva*—Average length 0.80. Color light yellowish-gray, darker just behind each joint, and very minutely shagreened all over. On each segment a prominent pointed straight projection each side of dorsum, and several minor warts and prickles below. Two very slightly raised, longitudinal lighter lines along dorsum, between the prominent prickles. Ten legs.

Perfect insect—Alar expanse 0.50; length of body 0.25. Color verdigris-green, the scales being sparse so that the wings appear sub-hyaline. Fore-wings with two transverse lighter lines dividing the wing into three parts, proportionate in width as 3, 4, 2 counting from base, and parallel with posterior margin; also a faint line between these two, running to about ⅓ of wing from costa. Hind wings with two similar transverse lines, dividing the wing in like proportion, the outer line not parallel with margin, but wavy and produced posteriorly near its middle. Costa pale; fringes obsolete. Head, thorax and abdomen green above, but, together with antennæ and palpi, white beneath.

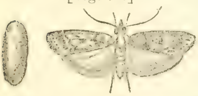
Described from one ♀ specimen.

THE GOOSEBERRY FRUIT-WORM, *Pempelia grossulariæ*, Packard.—Pl. 2, Fig. 17.

(Lepidoptera, Phycidæ).

On June 8th, I received from Mr. Geo. H. Cherry of Hematite, a number of diseased gooseberries, with an account of their prematurely turning red and rotting. The cause was a smooth thick glass-green worm which is more fully described below. Subsequently on the 12th of the same month, I received the same species of worm with a similar account of its work, from Mr. Stephen Blanchard, of Oregon; on the 16th from Jos. F. Bryant, of Bethany, with the statement that it was "feeding on and hollowing out" his currants, and on the 17th from Dr. W. A. Monroe of Bloomington with the statement that it was destroying his native gooseberries and Green gage plums. Mr. A. Fendler and F. R. Allen, both of Allenton, likewise informed me that it entirely ruined their currant crop, and I afterwards found the same insect on the currants and gooseberries wherever I went, and it doubtless occurs over the whole country, for as we shall presently see, it attacks the gooseberry both in the State of New York, Massachusetts, and in Canada.

[Fig. 79.]



a b

Dr. Fitch, in his 3d Report, §149, makes brief mention of it though he was not acquainted with the parent moth. He concludes his account in the following words: "I have sometimes seen bushes of the wild gooseberry with every berry withered and reduced to a mere dry hollow shell, with a cob-web like tube protuding from the orifice in one side. And the present summer a letter to the *County Gentleman*, from E. Graves Jr. of Ashfield, Mass., states that for three years past, his 'Houghton's seedling' gooseberries have been a total failure from this same worm, as I am assured by the account which he gives of it and the specimens accompanying his letter."

As soon as gooseberries and currants are well formed, this worm begins to make its presence known by causing the berries which it infests to prematurely turn red or dull whitish. After eating the inside of one berry, leaving a hole for the passage of the excrement, it enters another berry, making a passage way of silk, until it draws together a bunch of currants, or two or three gooseberries as the case may be. The berries thus attacked sometimes drop, but more generally the hollow shell mixed with cob-web-like silk shrivels up and hangs on to the bushes. During the latter part of June the worms descend from the shrub and spin for themselves brown cocoons (Fig. 79, *a*) in the leaves and rubbish on the ground. Here they change to brown chrysalids and remain in this state through the winter and come forth in the spring as moths. Thus there is but one brood of this insect each year, and yet by the middle of July there is never a worm to be found, and the chrysalis consequently remains quiescent alike through the hottest summer and the coldest winter weather. As the worms which I procured are still in the chrysalis state, I should have been unable to present the complete history of this pest, in this my first report, had it not been for the kindness of Mr. William Saunders of London, Canada, whom I met in Chicago, at the meeting of the "American Association for the Advancement of Science," and who very fortunately had with him specimens of the moth which he had bred from gooseberry-feeding worms, found in Canada, the description of which answered exactly to those of mine. But to make doubly sure that the insect which Mr. Saunders bred, is the same species as ours, I purposely forced one of my chrysalids. On the 25th of January, 1869, the markings of the wings showed through the chysalis skin, which was loose and brittle. These signs indicated that the forthcoming moth was in an advanced state of development, and on carefully taking away the chrysalis skin, it lay before me with nothing lacking to bring it to perfection but the inflating of the wings. Their markings were however perfect and distinct and agreed entirely with the Canadian specimen.

This moth is represented at Figure 79, *b* and still more faithfully at Plate 2, Figure 17, its general color being pale gray. It belongs to the genus *Pempelia*, and from advance sheets of Dr. Packard's "Guide" I learn that he has named it *P. grossulariæ*, and it may be known in English as the Gooseberry Pempelia.

REMEDIES.—Care should be taken to gather and destroy the worms while they are yet in the fruit, as they are afterwards found in the chrysalis state with great difficulty. If chickens are allowed to run amongst the bushes after the fruit has gone, they will materially assist in checking it by devouring such chrysalids as are within their reach.

PEMPELIA GROSSULARIÆ, Packard—*Larva*—Average length 0.65; thickest in the middle of body, tapering thence slightly each way. Color glass-green, partly translucent, shiny, and with a roseate hue on the upper surface. Head of a light gamboge-yellow, with tawny lips. Cervical shield not very prominent and of the same color. No other markings whatever. A few very fine white hairs, especially near the head and tail. 16 legs, the thoracic ones the same color as head, the others green.

Described from 10 specimens.

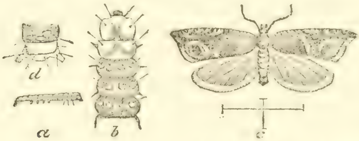
Chrysalis—Length 0.38. Of the normal form, and dull mahogany-brown color. The spiracles appearing like small tubercles and the extremity furnished with several stiff rufous curled bristles.

Perfect insect.—Length, including palpi, 0.40; alar expanse, 0.80. Color pale-gray. Front wings with a dark transverse diffuse band on the inner third, enclosing a zig-zag white line not reaching the costa. A dark discal spot, constricted in the middle, the upper and lower edges continued basally in the shape of two faint lines to the transverse band already mentioned, where they almost converge, the space enclosed by them being whiter than the rest of the wing, with a darker line along the middle. Beyond this discal spot, at about the outer fourth of the wing is another dark but less distinct diffuse transverse band, nearly parallel with posterior margin and with a white zig-zag line produced into an acute angle, basally, on the internal margin, the space between this band and the discal spot being also quite light. A row of marginal black dots, with the apex light. Fringes concolorous. Hind wings somewhat more dusky with darker margins and veins and lighter fringes. Head, thorax, abdomen, antennæ, palpi and legs all pale gray, being more silvery on the under than on the upper side.

One specimen from Wm. Saunders.

THE STRAWBERRY LEAF-ROLLER, *Anchylopera fragariæ*, Walsh and Riley—Pl. 2, Figs. 26 and 27.

[Fig. 80.]



The above figure represents an insect which devours the leaves of our strawberries. A more perfect picture of the moth is given enlarged at Plate 2, Figure 26, and of the natural size at Figure 27. It was first described in the January number of the *American Entomologist*, from which I take the following account of it.

For nearly two years, we have been acquainted with a little greenish leaf-roller, measuring about one-third of an inch, (Fig. 80, *a*), which in certain parts of North Illinois and Indiana, has been ruining the strawberry fields in a most wholesale manner; and which also occurs in Canada, judging from an account in the *Canada Farmer* of August 1, 1867. It crumples and folds the leaves, feeding on their pulpy substance, and causing them to appear dry and seared, and most usually lines the inside of the fold with silk. There are two broods of this leaf roller during the year, and the worms of the first brood, which appear during the month of June, change to the pupa state within the rolled-up leaf, and become minute reddish-brown moths (Fig. 80 *c*) during the fore part of July. After pairing in the usual manner, the females deposit their eggs on the plants, from which eggs in due time, hatches a second brood of worms. These last come to their growth towards the end of September, and changing to pupæ, pass the winter in that state.

We first heard of this leaf roller in the summer of 1866, when it did considerable damage at Valparaiso, Indiana, and we were informed by Mr. N. R. Strong, of that place, that in 1867 they continued their depredations with him, and destroyed 10 acres so completely as not to leave plants enough to set half an acre, and that in consequence of this little pest in conjunction with the White-grub, he has had to abandon strawberry culture.

When we met the *ad interim* committee of the Illinois State Horticultural Society at Lacon, in the beginning of July, 1868, we received from these gentlemen a quantity of infested strawberry leaves, from which in the course of the next two or three weeks we bred many of the moths. These specimens had been collected at Mr. Bubaugh's place, near Princeton, Illinois, where they were said to be very abundant, and to have completely destroyed one strawberry patch containing several acres.

Subsequently we received another lot of specimens from Mr. W. E. Lukens, of Sterling, Whiteside, county, Illinois, with the following remarks upon this very important subject:

"Where these insects are thick I would never think of raising strawberries. It is strange that I have not noticed any of their work upon this side the river; while on the south side for a mile up and down they are ruining the crops of berries. Removing the plants does not take with them the moth nor the eggs, so far as has been observed. A gentleman by the name of Kimball, at Prophetstown, had his crop a few years ago entirely destroyed by this insect, though it amounted in all to two or three acres. I hear of a great many men in other places having their crops burnt up with the sun, and have no doubt that it was this leaf-roller, and not the sun, that was the real author of the damage. As for myself, I have on this account entirely quit the business of growing strawberries."

The only modes of fighting this new and very destructive foe of the strawberry—which, however, seems to be confined to northerly regions—are, first, to plough up either in the spring or in the fall, such patches as are badly infested by it, by which means the pupæ will probably be buried and destroyed; and second, not to procure any plants from an infested region, so as to run the risk of introducing the plague upon your own farm.

We annex brief descriptions of this insect, both in the perfect and larval states. We are indebted to the distinguished English Microlepidopterist, H. T. Stainton, for the generic determination of the species, and for the further remark that "it is closely allied to the European *Anchylopera comptana* (Manual Vol. II, p. 225), which feeds on various Rosaceæ, such as *Poterium sanguisorba, Potentilla verna,* and *Dryas octopetala.*"

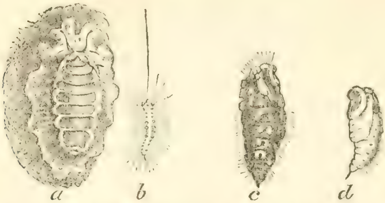
ANCHYLOPERA FRAGARIÆ, New species—Head and thorax reddish-brown. Palpi and legs paler. Antennæ dusky. Tarsal joints tipped with dusky. Front wings reddish-brown, streaked and spotted with black and white as in the figure. Hind wings and abdomen dusky. Alar expanse 0.40–0.45 inch. Described from nine specimens.

The Larva measures, when full grown, 0.35 of an inch. Largest on the first segment tapering thence very slightly to the last. Color varying from very light yellowish-brown to dark olive-green or brown. Body soft, somewhat translucent, without polish; the piliferous spots quite large, shining, always light in color, contrasting strongly in the dark specimens with the ground color. Hairs, especially lateral ones, quite stout and stiff. Spots arranged in the normal form, segments 2 and 3 having none, however, on their posterior half as have the rest (See Fig. 80, *b*) Head horizontal, of a shining fulvous color, with a more or less distinct dark eye-spot and tawny upper lip. Cervical shield of the same shiny appearance. Anal segment with two black spots (See Fig. 80, *d*) at posterior edge, being confluent and forming an entire black edge in some specimens. Legs, prolegs, and venter of the same color as the body above.

THE WHITE-MARKED TUSSOCK MOTH—*Orgyia leucostigma*, Sm. & Abbott.

(Lepidoptera, Arctiidæ.)

[Fig. 81.]

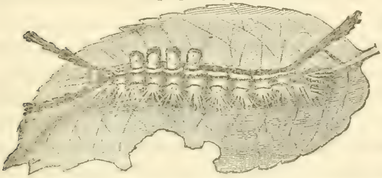


During the winter little bunches of dead leaves are sometimes found to be quite numerous on our apple trees. They are generally fastened to the twigs, and upon examination are found to contain gray cocoons. The greater portion of these cocoons have an egg-mass glued to them, which is composed of numerous perfectly round, cream-colored eggs, of about 0.03 diameter, and partly covered with glistening white froth-like matter; while the other proportion of these cocoons have no such egg-mass.

About the middle of the month of May these eggs begin to hatch, and continue thus to hatch in different parts of the orchard for over a month. The young caterpillar which hatches from these eggs is represented at Figure 81, *b*. It at first measures 0.10 in length, and is of a dull, whitish-gray color with the underside paler or of a dirty white, and with the tufts on the back of a dark brown. In two days after hatching, orange spots commence to appear along the back, and especially on segments 2, 3, 8 and 9. On the seventh day after having remained stationary for about two days, fastened to some part of the tree with silk, it casts its skin for the first time, after which operation the hairs are more numerous, the dark portions more intensely black-the orange parts of a brighter orange and the two tufts near the head longer. As it approaches the time of the second moult, the underside becomes more glaucous, a yellow line begins to appear at the sides, and in some cases the orange marks become yellow, with the exception of a small, perfectly round spot on segments 9 and 10 which always remains orange; the neck or first segment, where it joins the head, also becomes orange or yellow. Six days from the time of the first moult the second moult takes place, the worm having become lighter colored each day. Immediately after the shedding of the second skin it measures 0.30; the collar is more intensely orange as well as the head, while four cream-colored tufts appear on the back of segments 4, 5, 6 and 7, and the two round spots on segments 9 and 10 are of a very bright scarlet-orange. As it grows and approaches the third moult, the orange collar becomes more conspicuous, the back becomes of a perfect velvety black; the cream-colored tufts become smaller, whiter, and the fourth frequently obsolete; a transverse row of four yellow warts becomes conspicuous on segments 2 and 3; a subdorsal yellowish line appears, starting from segment 8 and running and diminishing posteriorly; the upper sides become of a dark bluish-gray, while the yellow line along the lower sides becomes more distinct. Six days after the second moult the third moult takes place with but little change in the appearance of the caterpillar, further than that the different colors become still more bright and distinct and the different tufts still larger.

Up to this time all the individuals of a brood have been alike, and of a size, so that it was impossible to distinguish the sexes. Six days from the third moult, however, the males measure not quite $\frac{3}{4}$ of an inch, and begin to spin their cocoons; while the females undergo a fourth moult about this time, and in about six days more they also spin up, having acquired twice the size of the male when he spun up.

[Fig. 82.]



The annexed Figure 82 represents the full grown female caterpillar, it differing from the full grown male only in its larger size. At this stage of its existence the caterpillar is a most beautiful object, with its vermillion-red head and collar, its cream-colored brushes and its long black plumes.

When young these caterpillars make free use of a fine web which they spin, and by which they let themselves down when disturbed, and it is quite amusing to watch them ascend again whenever they have become sufficiently assured that there is no danger. They perform this feat with the thoracic legs, using those of each side alternately, the body and head being thrown from side to side in harmony, very much as a sailor climbs a rope "hand over hand."

It may puzzle some persons to divine how such a hairy and tufted caterpillar can possibly cast off its skin and yet retain these pretty appendages. After having remained stationary without food for about two days, the old skin becomes dry and somewhat loose. If at this time this old skin be carefully removed, it will be found that an entirely new set of these appendages has been forming underneath it; the two long plumes curled over the head, down by the feet and up again to near the scaly collar; the four white brushes folded close together inwardly crossing each other; the anal plume folded below the anus, and all the other hairs laid in thread-like bunches close to the body in a posterior direction. In due time the old skin splits on the back, near the head, and the caterpillar gradually works it off posteriorly. The moment they are exposed the appendages which had been compressed, as described, to the body, commence to straighten out, and in a few minutes the new dress is displayed in all its beauty and freshness. The long plumes at the head do not straighten out of their own accord, however, for the caterpillar by a curious curling of the body, while resting on a few of its abdominal prolegs, cunningly brushes them with its tail end, first on one side, then on the other. It furthermore presses them, for the same end, one after the other against any surface on which it is at the time walking, and having once thoroughly straightened out its toilet it rests a few minutes from its efforts and then commences to feed with surprising vigor, apparently determined to make up for its two day's fast.

The male cocoon is white or yellowish, and sufficiently thin to show the insect within it. It is formed of two layers, the outer one having the tufts and plumes which adorned the maker, scattered through it. The female cocoon is twice as large and more solid and dense.

Soon after completing his cocoon the male changes to a chrysalis, which is represented of the natural size at Figure 81, *d*. The female, in due time, changes to a very different chrysalis, which is also represented life-size at Figure 81, *c*. In about two weeks after spinning up, the moths begin to issue. In this state the sexes are still more dissimilar. The male produces a winged moth, which is represented at Figure 83, while the female is furnished with but the merest rudiments of wings, and is destined to simply crawl to the outside of her cocoon, where, after the male has met her, she deposits her eggs, gluing and protecting them with the white frothy matter already described, which, at this time, has every appearance of spittle. She is faithfully represented at Figure 81, *a*, and after depositing her eggs, the body greatly contracts and she soon dies.

Fig. 83.

Such is an outline of the natural history of this pretty, but destructive caterpillar. In our State there are two broods each year, the moths of the first brood appearing during the latter part of May and fore part ot June, and those of the second brood in September and October. The periods given for the transformations are average periods, and in further illustration of the difficulty in drawing rigid lines of time, in the development of insects, I will state that from a hundred larvæ which hatch out in a single day, some will have produced moths while others are yet feeding in the caterpillar state.

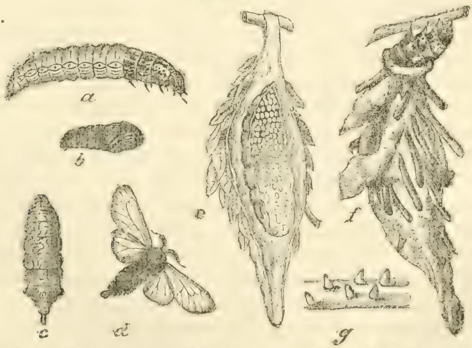
This insect seems to occur more or less over the whole country, and I have repeatedly received its egg-masses during the past two winters. It is, however, as we might expect from its nature, often confined like the Canker-worm, to particular orchards in a particular neighborhood. It feeds upon different kinds of trees, such as the elm, maple, horse-chestnut and oak, but it seems to prefer the apple, the plum, the rose and the pear.

REMEDIES.—Dr. Fitch has described two parasites, which attack this caterpillar, and I am acquainted with seven others, making in all nine distinct parasites, which prey upon this species. It was my intention to have described and figured some of these parasites, but the time in which this Report must be ready for the Public Printer forbids my doing so, the present year, and it suffices to say that in collecting the cocoons in the winter in order to destroy them, *none but those which have the egg-masses on them should be taken, as all the others, either contain the empty male chrysalis or else some friendly parasite!* From the fact that the female never travels beyond her cocoon, it becomes obvious that, since the insect can only travel in the caterpillar state, it would require over a century for it to spread even a hundred miles. Hence we may rightly conclude that it has been introduced to different parts of the country in the egg-state on young imported trees. How essential it is then to examine every tree in planting out a young orchard, and how easy it is with the proper precautions to forever keep an orchard free from its destructive work. As already stated, the young worms let themselves down upon slightly jarring the tree, and though after the third moult they lose this habit to a great extent, yet they may always be brought down by a good thorough shake, and where they have once invaded an orchard, this will be found the most feasible mode of killing them: though *prevention* by destroying the egg-masses in the winter when they are easily discerned, is infinitely the best and surest remedy against its attacks.

THE BAG-WORM, *alias* BASKET-WORM, *alias* DROP-WORM—*Thyridopteryx ephemeræformis*, Haworth.

(Lepidoptera, Psychidæ.)

[Fig. 84]



Our shade and ornamental trees are often defoliated by various insects, and I will give brief accounts of three which have attracted my attention during the past summer. Of these, the insect whose transformations are illustrated above, is by far the most common and injurious. It apparently flourishes better south of latitude 39° than north of that line. It occurs on Long Island, and in different localities in Pennsylvania, Ohio, Maryland, District of Columbia, the Carolinas, Georgia, Alabama, Kentucky, South Illinois and in the southern half of our own State, and doubtless in some of the other States, though I have no records to judge by. In St. Louis county it is very plentiful. Year after year shade trees are planted along the streets and avenues of this city, and year after year a great proportion of them dwindle and die, until at last the opinion very generally prevails among land-owners that it is of little use to try and grow them. Consequently they are not as generally planted as they should be, and St. Louis, with all her natural advantages, lacks to a great extent, those beautiful vistas and long rows of trees which so characterize and adorn some of our more Eastern cities.

Why is it that so many of these trees dwindle? No one seems to know! Can it be owing to the character of the soil, or of the climate? Most emphatically, no!—in these respects there is no more favored city on the continent, and for the proof we need only to visit Mr. Shaw's beautiful gardens, or Lafayette Park, or any of the nurseries around the city. What then, is the cause? Why, the very Bag-worm which forms the subject of this article. It swarms all over the city proper, but decreases in numbers, as a general rule, as one approaches or gets beyond the limits, and is comparatively rare in the above mentioned places. The reason for this is obvious when we understand its history, for it can spread but gradually, and has naturally multiplied most in those places where it has longest existed—namely, in the older parts of the town.

The natural history of the insect is interesting, and may be thus briefly given:

Thoughout the winter the weather-beaten bags may be seen hanging from almost every kind of tree. Upon plucking them many will be found empty, but the greater proportion of them will, on being cut open, present the appearance given at Figure 84, *e*; they are in fact full of soft yellow eggs. Those which do not contain eggs are the male bags and his empty chrysalis skin is generally found protruding from the lower end. About the middle of next May these eggs will hatch into active little worms, which, from the first moment of their lives, commence to form for themselves little bags. They crawl on to a tender leaf, and, attached to their anterior feet with their tails hoisted in the air, they each spin around themselves a ring of silk, to which they soon fasten bits of leaf. They continue adding to the lower edge of the ring, pushing it up as it increases in width, till it reaches the tail and forms a sort of cone, as represented at Figure 84, *g*. As the worms grow, they continue to increase their bags from the bottom, until the latter become so large and heavy that the worms let them hang instead of holding them upright, as they did while they were young. By the end of July they have become full grown, when they present the appearance of Figure 84, *f*. The worm on being pulled out, appearing as at Figure 84, *a*. This full grown condition is not attained, however, without critical periods. At four different times during their growth these worms close up the mouths of their bags and retire for two days to cast their skins or moult, as is the nature of their kind, and they push their old skins through a passage which is always left open at the extremity of the bag, and which also allows the passage of the excrement.

During their growth they are very slow travelers and seldom leave the tree on which they were born, but when full grown they become quite restless, and it is at this time that they do all their traveling, dropping on to persons by their silken threads and crossing the sidewalks in all directions. A wise instinct urges them to do this, for did they remain on one tree, they would soon multiply beyond the power of that tree to sustain them, and would in consequence become extinct. When they have lost their migratory desires, they fasten their bags very securely by a strong band of silk to the twigs of the tree on which they happen to be. A strange instinct leads them to thus fasten their cocoons to the *twigs* only of the trees they inhabit, so that these cocoons will remain secure through the winter, and not to the leaf-stalk where they would be blown down with the leaf.* After thus fastening their bags, they line them with a good thickness of the same material, and resting awhile from their labors, at last cast their skins and become chrysalids. Hitherto the worms had all been alike, but now the sexes are distinguishable, the male chrysalis (Fig. 84, *b*) being but half the size of the female chryalis (shown inside of the bag at *c*). Three weeks afterwards a still greater change takes place, the sexes differentiating still more. The male chrysalis works himself down to the end of his bag and, hanging half-way out, the skin bursts and the moth (Fig. 84, *d*) with a black body and glassy wings escapes, and when his wings are dry, soars through the air to seek his mate.—She never leaves her case, but issues from her chrysalis in the shape of an abortive, footless and wingless affair (Fig. 84, *e*) and after copulating, works herself back into the chrysalis skin, fills its upper but posterior end with eggs and stops up the other end with what little there is left of her body when she gets through. These eggs which are quite soft and yellowish, pass the winter protected in the bags, and produce young worms again the following spring, which go through the same cycle of transformations thus hurriedly described.

This insect is essentially polyphagous, for it occurs alike on ever-

*I have noticed that the Ailanthus tree is almost entirely exempt from the attacks of this worm, but cannot yet tell whether this is because the leaves are repulsive to it, or whether, the leaves being compound, the worm's instinct fails it, in that it fastens its case to the mid-stalk, which falls and carries the case with it to the ground. I incline to the latter belief however, from the fact that the insect is such a general feeder, and that a few isolated cases are sometimes seen attached even to Ailanthus twigs, showing that they can feed and mature on this tree.

green and deciduous trees. I have found it on the elms, the common and the honey locusts, Lombardy poplar, catalpa, Norway spruce, arbor-vitæ, Osage orange, soft and silver maples, sycamore, apple, plum, cherry, quince, pear, linden, and above all on the red cedar, while Mr. Glover has also found it on the cotton plant in Georgia. It is also exceedingly hardy and ruddy, and the young worms will make their bags of almost any substance upon which they happen to rest when newly hatched. Thus they will construct them of leather, paper, straw, etc., etc., and it is quite amusing to watch their operations.

NATURAL REMEDIES.—The only parasite which has been hitherto known to attack this Bag-worm is one known as *Cryptus inquisitor*, Say, which Mr. Glover figures on Plate 11, Figure 5, of his yet unpublished plates of four-winged flies. Last September, through the kindness of Miss M. E. Murtfeldt of St. Louis, I discovered another parasite which lives in the body of the worm to the number of five or six at a time, and which after destroying their victim, spin for themselves tough white silken cocoons within the bag, as represented at Plate 2, Figure 10. The Ichneumon fly which issues from these cocoons has never been described, and as the sexes differ remarkably, I subjoin a full description of each. The female is represented at Plate 2, Figure 11, and the male at Figure 12, and it will be seen at once that while the wings of the former are clouded, those of the latter are perfectly clear. This fly belongs evidently to the genus *Hemiteles* though it differs from most species in having the areolet wanting.

HEMITELES (?) THYRIDOPTERYX, N. Sp.—♀ Length, 0.36; expanse 0.50. Ferruginous, opaque. Head transverse, rather broader than thorax, the front much depressed; face prominent centrally beneath antennæ, closely punctured, thinly clothed with pale pubescence; clypeus and cheeks shining; tips of mandibles black; antennæ, long, slender, filiform, ferruginous, blackish at tips; thorax rugose; scutellum prominent, with sharp lateral margins; metathorax prominent, quadrate, abrupt laterally and posteriorly, finely reticulated and pubescent, the upper posterior angles produced on each side into a long, divergent, flattened, subacute spine; disk with two longitudinal carinæ, from which diverges a central transverse carina; tegulæ piceous; wings hyaline, subiridescent; a narrow, dark fuliginous band crosses the anterior pair a little before the middle, and a broad band of same color between middle and apex, this band having a median transverse hyaline streak; areolet wanting, second recurrent nervure straight, slightly oblique; apex of posterior wing fuscous; legs long and slender, ferruginuous, more or less varied with fuscous; posterior coxae, tips of their femora, and their tibiæ and tarsi, fuscous; base of four posterior tibiæ more or less whitish, forming a rather broad annulus on posterior pair; abdomen petiolated, subconvex, densely and finely sculptured, blackish, basal segment tinged with reddish, the second and third segments distinctly margined at tip with whitish; apical segments smooth and shining, thinly pubescent; ovipositor half as long as abdomen, sheaths blackish.

♂.—Not at all like the ♀. Length 0.33, expanse 0.44. Long, slender, black, polished without distinct punctures, thinly clothed with white pubescence; palpi white; antennæ long, slender; scape reddish; mesothorax gibbous, with two deeply impressed longitudinal lines; metathorax with well-defined elevated lines, forming several irregular areas; sides rugulose, apex without spines or tubercles; tegulæ white; wings whitish-hyaline, subiridescent, the nervures and stigma white, subhyaline, neuration as in ♀; legs long, slender, pale honey-yellow; coxæ, posterior trochanters, apex of their femora, and their tibiæ and tarsi, blackish; base of posterior tibiæ with a white annulus; abdomen long, slender, flattened, petiolated, smooth and polished, the apical margin of second segment being narrowly whitish.

Described from four ♀ and one ♂ specimens bred from the same cocoon.

Artificial Remedies.—From the natural history of this Bag-worm it becomes obvious, that by plucking the cases in the winter time, and burning them, you can effectually rid your trees of them, and I advise all who desire healthy trees to do this before the buds begin to burst in the spring. Where this is not done the worms will continue to increase, and partly defoliating the tree each year, slowly, but surely, sap its life.

In conversation some time since with Mr. Edward Cook, who is superintending the improvements in Washington Park, St. Louis, I showed him that every one of the young trees that had been lately planted there had from six to a dozen of these Bag-worms hanging from their twigs. I explained to him that the trees would never thrive with these parasites, and that, prevention being easier than cure, he had better have them plucked off at once, while they were within reach. He informed me afterwards that he had gathered two barrels full from these trees, but there are many yet left, which should be removed before spring.

THE AILANTHUS WORM—Larva of *Œta compta*, Clem., Plate 2, Figs. 22 and 23.

(Lepidoptera, Tineidæ.)

The Ailanthus is highly prized in most of our cities as a shade tree, and though there certainly are other trees as quick growing, and as hardy, which might advantageously take its place, yet as it has an almost perfect immunity from the attacks of the Bag-worm and continues to be grown, it will be of interest to know what insect enemies it has. Fortunately it has very few, but every St. Louisan must have noticed last fall that nearly all the young Ailanthus trees around the city, and in the parks, looked black and seared as though they had been scorched by fire. Few probably divined the cause of this phenomenon, but it was the work of the worm which is the subject of this chapter.

This worm is slender and of a very dark olive-brown color, with white longitudinal lines. During the months of August and September it may be found of all sizes, living in communities of from five to thirty individuals within a slight silken web. Did they but feed on the leaves their injury to the tree would be slight, but they have the miserable habit of gnawing the leaf stalk in two, and of severing the leaf, and causing it to turn black; thus marring the looks of large trees and killing many seedlings outright. When the worm is full grown it suspends itself in the middle of the loose web and changes to a chrysalis about ½ inch long and of a dull smoky-brown color. The chrysalis skin is so very fine, that as the future moth develops within, the colors of its wings show distinctly through it. The chrysalis state lasts on an average about two weeks, at the end of which time the moth bursts forth. In this state it is one of the neatest and most beautiful little moths that can well be imagined. At Plate 2, Figure 22, it is represented of the natural size, expanded, and at Figure 23 with the wings closed. The fore wings are of a bright metallic golden-orange, crossed transversely with bands of very pale chrome-yellow, marbled with black; while the underwings are smoky black, and almost transparent in the middle. The first moths begin to appear during the first days of September, and continue issuing from the crysalids till the last of October. From the fact that I could get none of them to deposit eggs, I infer that they pass the winter in the moth state—the more readily since I have had them escape from the crysalis even in November. They are very fond of flitting over and clinging to the flowers of the Golden rod and of the *Eupatorium serotinum.*

This insect probably occurs throughout the Southern States, for Mr. Glover has found it in Georgia. It is doubtless confined to the Ailanthus tree, though when pushed for food I found that the worms were not at all fastidious about devouring their brethren that were in the helpless chrysalis state. It was named *Pæciloptera compta* by the late Dr. Breckenridge Clemens, but as the genus *Pæciloptera* was pre-occupied in insects, Mr. A. Grote, of New York, proposed the generic term *Œta*, and we thus have a scientific name for our little moth—*Œta compta*—which the most prejudiced against the so-called "Crack-jaw-Latin" can hardly find objection to.

The easiest way of getting rid of the worms is to cut off the branch containing the nest and burn it.

Œta compta, Clemens.—*Larva.*—Average length when full grown 0.95. Slender, the diameter being 0.09. General color very dark olive-brown An extremely fine pearly-white dorsal and subdorsal line, and a somewhat more distinct stigmatal line of the same color; all three of them formed by minute white specks and lines. Dorsum, dull olive-green. A longitudinal line somewhat darker and in many cases quite black, below the subdorsal line. Between this last and stigmatal line is a stripe of the same color as dorsum, but speckled with white. Immediately below stigmatal line, it is rusty-yellow, especially on the middle segments. Venter sometimes olive-green, sometimes lead-color, finely speckled with white, and with a translucent line visible along the middle. This larva is mainly characterized, however, by a number of minute white piliferous spots, in strong contrast with the dark body, each giving forth a stiff white hair at right angles from said body. These spots are thus arranged on each side of every segment: 2 about the middle on subdorsal line; 1 under the anterior of these, just below the longitudinal dark line; 2 on the stigmatal line, with the stigmata which is of the same color between them; 1 in the orange part posteriorly; 2 small ones just below the orange part, and 2 in the middle of venter on the legless segments. Head of a beautiful brown, perpendicular, marked with black and speckled with white, two large spots being especially noticeable on the upper front. Cervical shield velvety-black, irregularly speckled with white. Thoracic legs black; abdominals extremely small and of the same color as venter; anals somewhat larger and brown.

Described from numerous specimens. The white spots are usually larger near the head while the hairs springing from them lean towards the head. The head itself is sometimes entirely black, while the white longitudinal lines are occasionally almost obsolete.

The young worm is pale and void of markings.

Chrysalis.—Average length 0.53. Not polished, but with the markings of the larva still apparent through the thin skin. General color dull smoky-brown, with a distinct broad dorsal band of a light rust-brown color along the abdomen, and a perfectly round spot of the same color on the top of the thorax, this spot generally giving forth a narrow orange line posteriorly.

Perfect Insect.—Average length 0.55; alar expanse 1.08. Fore wings bright lustrous golden-orange, crossed transversely with irregular bands of sulphur-yellow spots on a black ground as in the figure; fringes dense, narrow and brown. Hind wings smoky black, sub-hyaline except near apex and along margins; veins dusky, fringes also. Under surface of front wings dusky brown with the colors of the upper surface partly visible; under surface of lower wings concolorous. Head black with sulphur-yellow tufts; eyes black; palpi alternately black and sulphur-yellow; antennæ filiform, slightly serrate, black with a white shade along the upper terminal third. Thorax black with a wavy sulphur-yellow collar, golden-orange shoulder-covers with a spot of the same color between them, and two sulphur-yellow spots below this last. Abdomen steel-blue above, with a large brimstone-yellow patch on each segment below. Under surface of thorax black with brimstone-yellow patches; legs black, the front pair with yellow *coxæ* and orange thighs, the other four with more or less yellow, especially on the thighs.

Described from numerous specimens. No particular sexual difference, except in the form of the body.

THE WALNUT TORTRIX, *Tortrix Rileyana*, Grote—Pl. 2, Figs. 3 and 4.

(Lepidoptera, Tortricidæ.)

During the month of May large bunches of the leaves of the Black Walnut and of the Hickory may be found drawn together by a silky web, and living within these bunches, a nest of caterpillars of a yellow color and marked as at Figure 85, *a; b* showing a side view of one of the segments. During the latter part of the month they change to little honey-yellow chrysalids, within the nest, and by the middle of June these last work their way through the leaves to the outside, by means of rows of minute teeth which they have on the back. Here they hang in great numbers by the tips of their abdomens, and in a short time the moths escape.

[Fig. 85.]

This moth is represented at Plate 2, Figure 3, with the wings expanded, and at Figure 4 with wings closed. It is prettily marked, the fore wings being of an ochreous color with a golden tint, and darker spots, and the hind wings of a deep golden color. It was first described by Mr. Grote, of New York, in the Transactions of the American Entomological Society, Vol. II, p. 121. It was quite common in 1868 along the Iron Mountain road, and seems to be peculiar to Missouri. It also seems to prefer the young Hickories and Walnuts to the older or larger trees, as I found few nests that were out of reach.

On the Snowberry* (*Symphoricarpus vulgaris*), similar nests may be found at the same time of year, containing caterpillars agreeing in description with those feeding on the Walnut and Hickory, except in being smaller. They go through their transformations in the same manner and produce moths similarly marked but uniformly

*They also occur on the Ironweed (*Vernonia fasciculata*), though I have not bred the moth from worms feeding on this plant.

paler in color, of smaller size and with less contrast between the upper and lower wings. We have here an excellent illustration of what Mr. Walsh has called Phytophagic variation,† for the Snowberry and Hickory feeding worms were evidently of but one species, and the difference in the moths was caused in my estimation by the difference in food. Mr. Grote, it is true, describes the small form as the male and the large form as the female, but the difference is not sexual, as the two sexes occur alike in both forms.

TORTRIX RILEYANA, Grote—*Larva*—Length, Hickory feeding, 0.60-0.80; Snowberry feeding, 0.40-0.50. Largest on segment 2, tapering thence gradually to anus. Ground color dull yellow. Covered with large, distinct, black, sealing-wax-like, slightly elevated spots, each giving rise to several fine bristles. These spots are thus arranged on each segment: 2 each side of dorsum the posterior ones widest apart; 1 at sides in the middle of the segment, containing the stigmata in its lower hind margin; 1 smaller and narrower just below this, on a somewhat elevated longitudinal ridge, and 1 round one below this ridge on the posterior part of the segment. Segments 2 and 3 have but one spot each side of dorsum. Two distinct wrinkles on all the segments, more on 2 and 3. Head, cervical shield and caudal plate black. Venter dirty yellow with black marks; legs ditto.

Chrysalis—Honey-yellow, robust in the middle, and with two transverse rows of minute teeth across the back of each segment.

Perfect Insect—From Hickory—Average expanse 1 inch, length of body, 0.35. Deep ochreous. Fore wings evenly washed with purplish, leaving the fringes and costal edge dark ochreous. The markings take the shape of dark velvety brown rounded maculations, generally of small size and faintly shaded with ochreous on the edges. Three of these subterminally at the base of the wing, subequal, situated interspaceally between the nervures. At a little within the middle of the costa are two fused maculations, the most prominent. Before and beyond these, some faint costal marks. At the extremity of the discal cell, above median nervure, is the first of a series of maculations, normally four in number but not constant, usually uneven in size. A subterminal series of spots is inaugurated on costa by a large, compound shaded maculation. Below this, over the median nervules, sweeps an outwardly rounded series of small approximate dots. Two dots on costa, within and at the apex, and a faint terminal series of minute streaks is shortly discontinued. Hind wings of a lustrous bright deep ochreous; pale along the costal margin and darker shaded along internal margin. Beneath, as are the hind wings above; both wings immaculate, fore wings the darker. Body and appendages concolorous, bright deep ochreous. Antennæ simple. Numerous bred specimens.

From Snowberry—var. symphoricarpi—Much paler, the fore wings not being as dark as the hind wings of the above. The upper surface of fore wings not washed with purplish but merely of a darker ochreous than the hind wing. The maculations entirely similar but ferruginous, paler and the slighter costal marks obsolete. Legs at base and under thoracic surface almost whitish Average expanse, 0.62; length of body, 0.30. Described from numerous specimens. Under surfaces exactly alike in both varieties.

THE SEED-CORN MAGGOT, *Anthomyia zeas*—N. Sp.—Pl. 2, Fig. 24.

(Diptera Muscidæ.)

DESTROYING THE SEED AFTER IT IS PLANTED.

About the 20th of last June I received the following letter from A. S. Fuller, of Ridgewood, New Jersey:

"DEAR SIR: I send you, by mail, a small box containing kernels of sprouted corn, upon which you will find small white worms. Some of the corn fields in this vicinity are being ruined by this pest. These worms attack the corn before it comes up. What are they?"

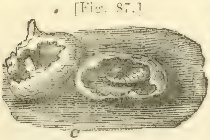
† See his paper in Proc. Phil. Ent. Soc., Vol. V, p. 194-216.

Subsequently I was informed that the seed-corn in other fields in Bergen county, New Jersey, was being destroyed in the same manner. The cause of this destruction is a footless maggot, measuring 0.25 to 0.30 of an inch in length, of a yellowish-white color, blunt at the posterior and tapering at the anterior end. It is a new foe to corn, and it is to be hoped that it is confined to the localities above mentioned. In order that it may at once be recognized, I give the following brief account of it:

[Fig. 86.]

This maggot is shown, enlarged, at Figure 86 *a*, the hair line underneath giving the natural size. It greatly resembles the Onion maggots, which are known to attack the onion in this country, and its work on corn is similar to that of this last named maggot on the onion; for it excoriates and gnaws into the seed-corn, as shown at Figure 87, and finally causes such seed to rot.

[Fig. 87.]



After having become full fed, these maggots usually leave the kernels for the surrounding earth, where they contract into smooth, hard, light-brown pupæ, of the size and form of Figure 86 *b*, and in about a week afterwards the perfect fly pushes open a little cap at the anterior end, and issues forth to the light of day. In this state it is a two-winged fly belonging to the order Diptera, and quite inconspicuous in its markings and appearance. Though I bred but two females, and this sex fails to exhibit some of the most important generic characters, yet there is nothing in the females of this species to distinguish it from the genus *Anthomyia* proper, of Meigen, as restricted by Macquart, and this Corn maggot, therefore, belongs to the same genus as the imported Onion fly (*Anthomyia ceparum*, Meigen). Upon submitting a specimen, for inspection, to Dr. Wm. Le Baron, of Geneva, Illinois, who has paid especial attention to our two-winged flies, he informed me that it is distinct from any hitherto described North American species, and I have, therefore, called it the Corn Anthomyia (*Anthomyia zeas*).

ANTHOMYIA ZEAS ♀, N. SP. (Pl. 2, Fig. 24). Length 0.20; alar expanse 0.38. Antennæ black; style mircoscopically pubescent; front, fulvous, with a distinct, rather narrow, brownish, cinereous margin; face and orbits brownish-white; palpi and proboscis black; ocellar area somewhat heart-shaped; thorax and abdomen pale yellow-brownish cinerous, with minute black points at the insertion of the bristles; thorax with an indistinct middle stripe of brown; legs black, tinted with cinereous; poisers pale orchre-yellow; scales small, the upper valve larger than the lower.

It is difficult to suggest a remedy for this pest, as its presence is not observed till the mischief is done. Hot water has been found effectual in killing the Onion maggot, without injuring the onions, and would doubtless prove as effectual for this Corn maggot, where a few hills of some choice variety are attacked, which it is very desirable to save. But its application in a large field, even if one knew where to apply it, would be impracticable, and I can only suggest soaking the seed, before planting, in gas-tar or copperas, and hope that the experiment will be tried next spring by those of our Eastern friends who have suffered from this maggot.

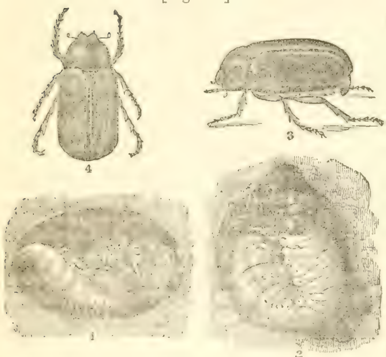
The larvæ of the genus *Anthomyia* live, for the most part, on vegetable matter, and seem to prefer it in a state of decay. Some, however, breed in excrement. Besides this corn species and the onion maggot already spoken of, there is one in this country that attacks radishes, and another that attacks the stem of cabbages. Specimens of this last species have been sent to me by Professor A. N. Prentiss, of Michigan Agricultural College, with the statement that they were proving very injurious to this esculent, around Lansing, in that State, and the flies produced from them seem to be identical with the species that attacks the cabbage in Europe (*Anthomyia brassicæ*, Bouché).

THE WHITE GRUB.

Larva of the May-beetle, *Lachnosterna quercina*, Knoch.

(Coleoptera, Melolonthidæ.)

[Fig. 88.]



The "White Grub is one of the very worst and insidious of the farmer's foes. To give its metamorphoses at a glance, and to obviate the necessity of verbal descriptions of so common an insect, I have prepared the annexed figure (88) which illustrates the full grown larva (2), the pupa (1), and side and back views of the beetle (3 & 4).

The following letter from Mr. Jno. P. McCartney, of Cameron, is a sample of numerous accounts of its depredations which I have received during the year.

"CAMERON, MISSOURI, Sept. 21, 1868.

"MR. C. V. RILEY, *Dear Sir:* The White grub worms have done us in this part of the State a great deal of damage. Will you please give us a history of the insect's habits. The grubs are now full grown, fine fat fellows. Two years since (1866), during the last of May, the beetles were very plenty. After sundown they came in great numbers and swarmed around the tops of the trees on the lawn, making a noise like the coming up of a storm of wind and rain. Last year (1867), the grubs did but little damage. What we want to know is, when will they leave the ground again as beetles? If they spend another summer in the ground it will be of but little use to try and raise a crop on the land that is now full of them. They have ruined all the meadow in tnis vicinity."

It is characteristic of the beetle to appear in vast swarms during the month of May—earlier or later, according to season or latitude. The beetle is quite voracious, and often greatly injures both fruit and ornamental trees. I have known the Lombardy poplar to die, in consequence of the utter denudation they caused; while last June certain groves of both Pin and Post oaks on the farm of Mr. Flagg, of Alton, Illinois, were so thoroughly and suddenly denuded by them, that Mr Flagg could not at first divine the cause. Their existence in the beetle state is however short, and as they are confined to the foliage, their injuries are exceedingly small compared with those which their larvæ inflict upon us. Our meadows, strawberry beds, corn, vegetables, and even young nursery stock, are all subject to the attacks of these White grubs, and often ruined by them. Soon after pairing, the female beetle creeps into the earth, especially wherever the soil is loose and rough, and after depositing her eggs, to the number of forty or fifty—dies. These hatch in the course of a month, and, the grubs growing slowly, do not attain full size till the early spring of the third year, when they construct an ovoid chamber, lined with a gelatinous fluid; change into pupæ, and soon afterwards into beetles. These last are at first white, and all the parts soft as in the pupa, and they frequently remain in the earth for weeks at a time till thoroughly hardened, and then, on some favorable night in May, they rise in swarms and fill the air.

This, is their history, though it is very probable, as with the European Cock-chafer (a closely allied species), that, under favorable conditions, some of the grubs become pupæ, and even beetles, the fall subsequent to their second spring; but growing torpid on approach of winter, remain in this state in the earth, and do not quit it any sooner than those transformed in the spring. On this hypothesis, their being occasionally turned up in the fresh beetle state at fall plowing, becomes intelligible.

Remedies.—As natural checks and destroyers of this grub, may be mentioned the badger, weasel, skunk, marten, the crow, and the different hawks, but especially the Ground beetles among insects, some of which have been figured on page 115. Hogs are fond of them, and a gang may be turned into an infested meadow, which is to be cultivated the next year, with good advantage. The grub sometimes so thoroughly destroys the roots of meadow grass that the sward is entirely severed; in such cases a heavy rolling would doubtless kill great numbers of them. Applications of ashes and salt have been recommended, but I think they are of doubtful utility, unless sufficiently applied to saturate the ground to the depth of more than a foot. A field or meadow is badly injured during a certain year by the full grown grubs. The following spring the owner, ignorant of the insect's history, applies some substance to the land as a remedy, and finding no grubs during the summer following, will naturally conclude his application was effectual, when in reality the insects left of their own accord in the beetle state.

During their periodical visits as beetles, they should be shaken from the trees, gathered up, scalded and fed to hogs. As an illustration of what may be done in the way of hand-picking, I will state that under the efforts of M. Jules Reiset, the incredible amount of 160,000 kilogrammes, or about eighty millions of similar White grubs were collected and destroyed in a portion of the Seine-Inferieure of France, during the autumn of 1866.

The beetles make their appearance in different localities with great regularity every three years, and in a case like that communicated by Mr. McCartney, I should advise him to plant freely next spring without fear of their ravages; for he may rest confident that they will issue as beetles next spring and not be very troublesome again, as grubs, till the summer of 1871. At Unionville, according to Mr. A. L. Winchell, the beetles appeared "in millions" last spring, and I hope soon to be able to give the years in which they will appear in the different localities throughout the State. The White Grub is subject to the attack of a curious fungus, which the following item from the Sedalia, Pettis county, *Press* very well describes:

"W. B. Porter, of this county, has left at our office a specimen of the White Grub, so formidable as a corn, potato, and grass destroyer. There are two sprouts of green, vegetable growth, growing out of the head of the *grub*, one on either side, of nearly half an inch in length, resembling a hog's *tusk* in shape. Mr. Porter informs us that the one presented is by no means an isolated example, but that myriads of them can be found which present the same anomalous combination of animal and vegetable life. Who will explain this aberration from the well settled laws of organic life?"

In the second volume of the late *Practical Entomologist*, page 16, an account was given of the same fungus, great numbers of the grubs on Mr. Paulding's place at Tipton, Iowa, being affected with it. Dr. Kirtland, of Ohio, also evidently refers to the same fungus as being well known to science in the *Prairie Farmer* for 1865, Vol. XVI, p. 71. At Figure 89, I represent one of the grubs as it appears when attacked by this fungus, drawn from specimens received from Mr. Porter. The sprouts are almost invariably two in number and proceed from the corners of the mouth, but in one specimen which I have, there is but one near the mouth, the other protruding from the middle of the back.

[Fig. 89.]

In Virginia the grub seems to be attacked by another fungus, as the following letter of Mr. Sam. H. Y. Early, which was communicated to Mr. Walsh by the well known Entomologist, Wm. H. Edwards, abundantly shows:

"There is a white mushroom known in the region in which I was raised, as poisonous and fatal to the hogs that feed on it. I believe it is common in all localities in which I have been. In the spring of 1842 I observed in what is called a 'new ground' in Virginia a great quantity of these mushroom, and in reply to some remark I made about them, some of my father's negroes, who were then making hills with hoes for planting tobacco, inquired of me if I knew what produced these mushrooms. On my replying in the negative, I was informed that they grew from the White grub worm. I think there were some twelve or fifteen negroes present, all of whom curcurred in the statement, and said it was no new thing to them. They had no difficulty in establishing the truth of what they stated, because they dug them up in all their stages of germination and growth before my own eyes. In a very short time they had furnished me with a large number of the worms in their original shape, features and size, and as distiuct to the eye as if they had been alive, but having the consistency, color and smell of a mushroom; and I actually broke them up, just as a mushroom breaks in one's hands, snapping them crosswise and sqarely off. Many others I found to be enlarged before germinating, and many just germinating, but with the shape of the worm preserved. And in some I noticed that the features of the worm were preserved in the root, even after the mushroom had grown up through the earth and attained some size. I gathered a good many specimens in their various stages into my handkerchief, and carried them to my father's house, where they lay on the mantel for some time. They seemed, however, to be no novelty to many to whom I exhibited them. In fact they were familiar to almost all who had opportunities of investigation, and to whom I mentioned them at the time."

Whether there is any relation between these two fungoid growths further investigation will alone tell; but when we shall have become better acquainted with them we may possibly be able, by sowing the spores of either kind to effectually kill the White Grubs in our fields.

THE AMERICAN MEROMYZA—*Meromyza Americana*, Fitch.—Pl. 2, Fig. 28.

(Diptera Muscidæ.)

ATTACKING WHEAT.

About the middle of the month of June last, in all the wheat fields which I examined between Bluffton on the Missouri river and St. Louis, I noticed that a great many of the ears had prematurely ripened, had turned yellow and were stunted and shorter than the rest, and upon examination the kernels proved to be withered and shrunken.

In most fields about one per cent of the ears were thus affected, but in two fields near Hermann, from three to four per cent were injured in this manner. This appearance was variously attributed to Hessian fly, Midge, etc., etc., no one seeming to know the true cause. Upon

[Fig. 90.]

examination I found that the last or ear-bearing joint could invariably be pulled out of its sheath with but a slight effort, and that it was perfectly yellow and dry, while the lower end bore an irregular and gnawed appearance. Upon splitting open the first joint of the stalk, a space of about a quarter of an inch was found to be completely corroded, so to speak, and filled with excrementitious matter, as shown at Figure 90, *a*. In this space would generally be found a pale watery-green maggot of the form of Figure 90, *b*, attenuated at one end and blunt at the other. I took a number ef infested stalks home, and many of the maggots changed to green pupæ of the form and appearance of Figure 90, *c*. Before changing to pupa the maggot would sometimes crawl away from the joint and get nearer the head, between the stalk and the sheath. The pupa state lasted from 12 to 14 days, and the first flies emerged during the first week in July.

This fly is represented, magnified, at Plate 2, Figure 28, and belongs to the genus *Meromyza* in the family Muscidæ of the order Diptera. It appears to be the very same species which Dr. Fitch found flying about wheat fields in New York State, and which he described and named as the American Meromyza (*Meromyza Americana*), on page 299 of his 1st and 2d Reports.* He did not ascertain the habits of the larva, however, and they have ever since remained unknown. The fly measures, on an average, 0.17 to the tip of the abdomen, and expands about 0.20. It is of a pale yellowish-green, the head being more inclined to straw color. The eyes are black and there is a round black spot between them on the top of the head. There are three broad black stripes, with a bluish-gray cast, on the thorax, the middle one straight and extending anteriorly to the pedicel of the neck, the outer ones slightly rounded outwardly, not extending so far anteriorly, but extending around the scutel and joining the middle one posteriorly. The abdomen also has, above, three broad blackish stripes, which are confluent posteriorly and interrupted at each of the sutures. Wings prismatic, hyaline and greenish anteriorly, their veins and the tips of the feet being dusky.

In Europe the larvæ of the closely allied genera *Chlorops* and *Oscinis* have long been known to attack some part or other of the stalks of wheat, rye, barley and other small grains. Several species are figured and described by the English Entomologist Curtis in his

* My specimens are all somewhat smaller than Dr. Fitch's according to his description, and have black eyes instead of "bright green;" but upon submitting specimens to Baron R. Osten Sacken who makes a specialty of *Diptera* he referred it to the same species.

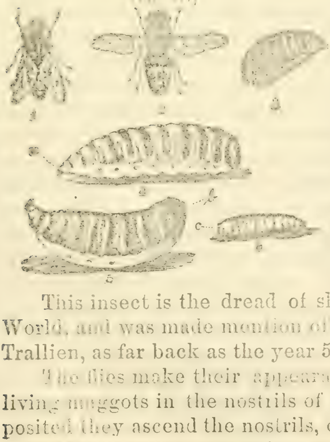
"Farm Insects," and one of them—the *Oscinis vastator*—though a very different fly, seems to have almost precisely the same habit as our insect. It is quite probable, also, that in this country as in Europe, there are two broods during the year, the second brood of larvæ attacking grain sown in the fall, but further investigation alone will decide these points.

. REMEDIES.—Much can be done in an artificial way by cutting off and destroying all the infested stalks, which may readily be recognized by the signs already described; but even if this plan should faithfully be carried out, it is doubtful whether it would pay in a country where labor is so scarce and demands such high wages as in ours. We therefore have to fall back on the only practical means within our reach, viz: that of varying the culture by alternate courses, and this style of cultivation will have to be more generally adopted, should this pigmy foe sufficiently increase as to greatly diminish the yield of the "staff of life." There is every reason to believe, however, that Nature has her own means of keeping these flies within due bounds, for they are known to be preyed upon by parasitic Ichneumon flies in Europe, and I noticed many flies of this last description, of polished hues and active movements, deftly darting through, and resting upon the wheat plants of the fields infested with the *Meromyza*.

THE SHEEP BOT-FLY, OR HEAD MAGGOT.—*Œstrus ovis*, Linn.

(Diptera, Œstridæ.)

(Fig. 91.)



For the benefit of sheep raisers I give the following brief account of the insect which causes "Grub in the head." The annexed illustration (Fig. 91) represents it in all its stages. 1 shows the Gadfly, life size, with wings closed; 2 the same with wings expanded; 3, the pupa from which the fly has escaped; 4 the full grown larva, dorsal view; 5 the same, ventral view; 6 the same when younger.

This insect is the dread of sheep in the Old as well as the New World, and was made mention of by the Greek physician, Alexander Trallien, as far back as the year 560.

The flies make their appearance in June and July, and deposit living maggots in the nostrils of the sheep. As soon as they are deposited they ascend the nostrils, causing great irritation on their way, until they reach the frontal sinuses; there they attach themselves by the little hooks or tentacula placed each side of the head, to the membranes which line the cavities, feeding on the mucus which is always to be found in them. Until they attain their growth they are of a creamy white color, with two brown spots placed side by side on the posterior segment. These spots, (6, *c*) are spiracles or stigmata, through which the worm breathes. The segment with these two spiracles, is retractile, and can be drawn in and hidden at the worms pleasure. When full grown, the grub becomes darker, particularly towards the tail, the white of the first two or three segments becoming dirty white on the 4th or 5th, and growing darker on each successive segment until the last, which is of a very deep brown. It has two small parallel hooks or tentacula at the head (*a*), and above these, two very small tubercles, not very easily shown in the engraving. It also has a small brown elevated round spot on each segment along the sides, which might at first be taken for spiracles but which are not, and also two small corneous appendages (5, *b*) on each side of the anus. The ventral region has a band of small elevated dots running the breadth of each segment in their middle, which, under the magnifier appear to be minute brown spines, all pointing posteriorly. (See Fig. 91, 5). These aid the worm in its movements.

When ready to contract into a pupa, it descends down the nostrils of the sheep and falls to the ground, where it quickly buries itself and in about 48 hours, contracts to half its former size, and becomes smooth and hard and of a black color, tapering as in the larva towards the head. It remains in this state from 40 to 50 days, or more, according to the weather, when the fly pushes open a little round cap-piece at the head and thus arrives at maturity.

In this stage it looks something like an overgrown house-fly. The ground color of the upper part of the head and thorax is dull-yellow, but they are so covered with little round elevated black spots and atoms (scarcely distinguishable without the aid of a magnifier) that they have a brown appearance. The abdomen consists of 5 rings, is velvety and variegated with dark brown and straw color. On the under side it is of the same color, but not variegated in the same way, there being a dark spot in the middle of each ring. The feet are brown. The under side of the head is puffed out, and white. The antenæ are extremely small and spring from two lobes which are sunk into a cavity at the anterior and under part of the head. The eyes are purplish brown, and three small eyelets are distinctly visible on the top of the head. It has no mouth and cannot therefore take any nourishment. The wings are transparent and extend beyond the body, and the winglets, which are quite large and white, cover entirely the poisers. Its only instinct seems to be the continuation of its kind. It is quite lazy, and except when attempting to deposit its young, its wings are seldom used.

It has lately become the fashion with many members of the Agricultural press, to ridicule the idea that sheep die at all from grub in the head, and many even deny that the grub is capable of any injury to the sheep whatever. From the fact that this grub may be found in the head of almost every sheep that dies, in the Western States at least, it is undoubtedly true that many other diseases are cloaked by the popular verdict of "grub in the head." It is none the less true, however, that those Agricultural editors, who pretend to instruct, simply show their lack of practical knowledge, in butting against that which must be the firm conviction of every flock master, viz: that sheep do die *of* grub in the head, Messrs. Youatt and Clark notwithstanding.

Mr. Youatt declares: "It is incompatible with that wisdom and goodness that are more and more evident in proportions as the phenomena of nature are closely examined, that the destined residence of the *Œstrus ovis* should be productive of continued inconvenience or disease." I agree most decidedly with Mr. Randall, that "this is as far fetched as a conclusion, as the reasoning on which it is founded."

If grub in the head is not productive of inconvenience or disease, as the disciples of Youatt have it, whence the suffering condition, the loss of appetite, the slow, weak gait, the frequent coughing, the slimy and purulent matter, sometimes so profusely secreted as at times to almost prevent the animal breathing? Whence the tossing and lowering of the head, and the fits of frenzy, to which so naturally quiet and gentle an animal as the sheep is subject? All these symptoms result from grub in the head, and the animal frequently gets too weak to rise, and finally dies. These effects of the grub were well recognized and understood by such old writers and close observers as Reaumur and Kollar; while Mr. Dan'l Kelly, of Wheaton, Illinois; Towne Bros., of Geneva, Illinois; M. L. Cockrill, of Tennessee, and other well known flock-masters with whom I have either conversed or corresponded, are unanimous in ascribing these symptoms to the true cause; and the late S. P. Boardman, of Lincoln, Illinois, coincided with them in this respect. For my part, I would as soon believe that those parasites were beneficial, which are so injurious to man, either internally or externally, or those which prey upon our caterpillars and other insects, and invariably destroy them; for although, when there are but few grubs in the head, the injury they inflict is not perceptible, *they can never be beneficial*, and when numerous enough will undoubtedly cause death. They cannot live in the head of the sheep without causing great irritation by the spines with which the ventral region is covered and the hooks with which they cling to such a sensitive membrane as that which lines the sinuses. Moreover, when numerous enough to absorb more mucous than the sheep secretes, the grubs will feed on the membrane itself, and (according to the evidence of some practical sheep men) will even enter to the brain through the natural perforation of the ethmoid bone, through which pass the olfactory nerves; in either of which cases, they must cause the most excruciating pain. The natural fear also, which sheep have of the fly, and the pains they take to prevent its access to the nose, is of itself proof enough that it is obnoxious to them. The rabbit is subject to the attack of a very large gad-fly (the *Cuterebra cuniculi* of Clark). I saw a half grown rabbit the past summer with an enormous swelling each side of its neck. On examination these swellings were found to be caused by the grubs of this fly, and the rabbit was so weakened and emaciated that it could scarcely move. No one could witness such a sight without being convinced that the parasite was injurious.

In the *Prairie Farmer* of October 14, 1865, the fact was published that the Sheep Bot-fly deposits *living* maggots in the nostrils of the sheep. It was published on the authority of Mr. Kelly, and both he and myself then believed it to be the first published account of the viviparous nature of this fly. But the following extract from a letter from the late lamented Samuel P. Boardman, of Lincoln, Illinois, shows that the same discovery has been made by three independent observers in this country. Mr. Boardman wrote as follows:

"All the authors, both European (at least all *English*) and American, from Youatt to Randall, will persist in saying that the fly deposits an egg, which hatches out, and crawls up the nostrils of the sheep, etc., etc. Now three independent and perfectly original discoverers have in our own country within twenty five years past, disproved the book account of the grub's transformations.

"John Brown—'Old Ossawattomie John Brown,'—published an account in an Agricultural paper (I forget what one) about twenty years since, of his seeing, 'with his own eyes,' the fly drop the *perfectly formed and living grub* in the nostrils of sheep. Some seven years since, 'Old Dan Kelly,' of Du Page county, Illinois, made the same discovery and supposed that he was the only man who had ever done it. At the time he made known his discovery, at a meeting of the Illinois State W. G. Association held in Chicago, I thought also, that he was the first man to ever notice the like. Two or three years afterwards I saw the account of John Brown's discovery, in the *Ohio Farmer*, copied from an old paper dated about seventeen years previously. When Kelly and I were at the meeting of the National W. G. Association, I went with him to the *Ohio Farmer* office, and I found in the file, Old John Brown's account. Mr. Kelly took a copy of the *Farmer* containing it, home with him. That makes *two* perfectly original and independent discoveries of the fact alleged. Now then, within a year past (I think) I have seen a letter from Mark Cockrill, of Tennessee, (who, before the war, was one of the oldest, largest and richest wool growers in the South, as well as one of the richest men in the South), in which he speaks of having made the same discovery years ago, and in which he speaks of it as if he thought he was the only, and original discoverer. Here are three men widely separated, who, we must acknowledge, are all capable and honest observers, and yet, Randall, (or at least his publisher) continues to put forth in every new edition of the '*Practical Shepherd*,' the same old exploded (or should be) notion of the fly depositing *an egg*. I presume it is altogether likely that all modern English writers on sheep keep up the same thing—by copying from Youatt."

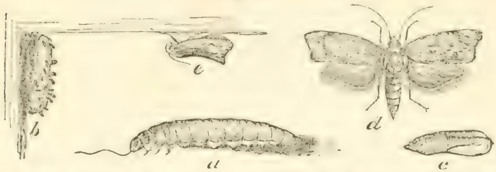
On one occasion in 1866, I myself obtained living maggots from one fly and Mr. Cockrill has since obtained over 300 living, moving worms from one that was caught while she was after the sheep. Many flesh-flies, if they cannot find suitable meat or carrion on which to lay their eggs, retain these egg so long in their bodies that they hatch there, into living larvae; and it is not impossible that the above observations were made with flies that had been so circumstanced, but I think it highly improbable, and strongly incline to believe that it is the normal nature of this fly to produce living larvae. I incline to this belief the more strongly, from the fact that it would be difficult to attach an egg to the slimy nostrils of a sheep.

To prevent it from depositing its young, different means are resorted to. Mr. Randall says that "some farmers turn up the soil in portions of their pastures, so that the sheep may thrust their noses into the soft ground, on approach of the fly, while others smear their noses with tar, or cause them to do so themselves." But as the fly is very persevering, and generally attains her object, the means to be depended on the most, is the dislodging of the larva, or "grub," and so far, lime has been thought to be the most effectual, and should be given them, that they may by sniffing it, cause sneezing, and in many cases dislodge the grub. Some sheep keepers even shut their sheep up for several nights, in a tight barn, when first taken up in the fall, believing that the close and heated atmosphere induces the grub to descend and is therefore more readily dislodged, and that the injury accruing from such foul air, is trifling, compared with the benefit received by dislodging the grubs. Other sheep breeders are in the habit of fixing salt logs in their pastures, of sufficient length to enable all the sheep to get at them. Into these logs, at distances of five or six inches, holes are bored with a two-inch auger, and during fly season a little salt is kept in these holes, while every two or three days tar is smeared around them with a brush. The sheep in obtaining the salt, tar their noses, and the odor of the tar keeps the fly away. In severe cases where the grubs are already in the head, they may be dislodged in a measure, by a feather dipped in turpentine, which should be run up the nose and gently turned.

INSECT ENEMIES OF THE HONEY-BEE.

THE BEE-MOTH OR WAX-WORM,—*Gallerea cercana*, Fabr.

[Fig. 92.]



Large hawk-moths sometimes enter a beehive for what honey they can get, and even mice have been known to enter a hive; while several parasites live upon the bees themselves. In our own State as I shall presently show there is a large two-winged fly which seizes the bee while on the wing and kills it. But by far the worst enemy the bee-keeper has to contend with, is the Bee-moth (*Galleria cereana*, Fabr). This insect is so well known to bee men generally, that it scarcely needs a description. It is well illustrated above (Fig. 92) in all its stages, *a* showing the full grown worm, *b* the cocoon which it spins, *c* the chrysalis to which it changes, *d* the female with wings expanded, and *e* the male moth viewed from the side with the wings closed. It suffices to to say, that the color of the moth is dusky gray, the fore wings which are scalloped at the end, being more or less sprinkled and dotted with purple-brown. The female is generally a good deal larger than the male, though there is not so much difference between the sexes as some writers have supposed. The worms which produce these moths are of an ash-gray color above, and yellowish-white beneath.

The Rev. L. L. Longstroth, in his excellent work on the Honey-bee, which every bee-keeper should possess, has given such a complete account of the Bee-moth, that it is only necessary for me to mention a few of the most important facts with regard to it, my object being principally to show that there can be no such thing as a *moth-proof hive*; that wire-gauze contrivances are of no avail, and that the man who pretends to sell a moth-proof *hive*, may usually be set down as a know nothing or as a swindler.

The Bee-moth was first introduced into this county from Europe, about the commencement of the present century, and it was in all probability imported with the common bee-hive. There are two broods of the moth each year, the first brood appearing in May and June, and the second, which is the most numerous, in August. During the day time, these moths remain quietly ensconced in some angle of the hive, but as night approaches, they become active, and the female uses her best endeavors to get into the hive, her object being to deposit her eggs in as favorable a place as possible. Wire-gauze contrivances are of no avail to keep her out, as she frequently commences flying before all the bees have ceased their work. But even if she were entirely prevented from entering the hive, she could yet deposit her eggs on the outside, or by means of her extensile ovipositor, thrust them in between the slightest joint or crack, and the young worms hatching from them, would readily make their way into the hive. The moment the worm is hatched, it commences spinning a silken tube for its protection, and this tube is enlarged as it increases in size. This worm cuts its channels right through the comb, feeding on the wax, and destroying the young bees on its way. When full-grown, it creeps into a corner of the hive or under some ledge at the bottom, and forms a tough white cocoon, of silk intermingled with its own black excrement as in figure 92, *b*. In due time the moth emerges from this cocoon.

A worm-infested hive may generally be known by the discouraged aspect which the bees present, and by the bottom-board being covered with pieces of bee-bread mixed with the black gunpowder-like excrement of the worm. It must not be forgotten, however, that in the spring of the year, pieces of bee-bread at the bottom of a hive *when not mixed with the black excrement*, is not necessarily a sign of the presence of the worm, but, on the contrary, may indicate industry and thrift. If a hive is very badly infested with the worm, it is better to drive out the bees and secure what honey and wax there may be left, than to preserve it as a moth breeder to infest the apiary. If put into a new hive, the bees may do something, and if they do not, there is no loss, as they would have perished, finally, from the ravages of the worm.

It should invariably be borne in mind that a strong stock of bees is ever capable of resisting, to a great extent, the attacks of the worm; while a starved or queenless swarm is quite indifferent to its attacks. In a common box hive, a good way to entrap the worms after they are once in a hive, is to raise the front upon two small wooden blocks, and to put a piece of woolen rag between the bottom-board and the back of the hive. The worms find a cozy place under the rag, in which they form their cocoons, and may there be found and killed, from time to time. Much can be done in the way of prevention, by killing every morning, the moths which may be found on the outside of the hives. At this time of the day, they allow themselves to be crushed, with very good grace; and if two or three be killed each morning, they would form an important item at the end of the year, especially when we recollect that each female is capable of furnishing a hive with at least 300 eggs. In conclusion, I give it as my conviction that immunity from the ravages of this Bee-worm can only be guaranteed where a thorough control is had of both hive and bees; hence the great importance of the movable frame hive.

THE BEE-KILLER—*Trupanea apivora*, Fitch.

(Diptera, Asilidæ.)

[Fig. 93.]

In the last chapter of his 9th Report, Dr. Fitch describes a fly by the name of the "Nebraska Bee-killer," which he received from Mr. R. O. Thompson, of Nursery Hill, Otoe county Nebraska, and which the latter named gentleman had found preying upon the bee in North Nebraska in the summer of 1864. Mr. Thompson has since removed from Nebraska to North Missouri, and in conversation with him last summer he informed me that he had met with this Bee-killer each year since 1864, and that it seemed to be increasing. At a later day, in a communication to the *Rural World* of September 1[illegible], 186[illegible], he states that it made its appearance in such numbers in North Missouri last summer, that it to a great extent prevented the bees from swarming. I present above at Figure 93 a life-size portrait of this voracious insect, its general color being yellowish-brown or yellowish-gray. This figure will enable its ready recognition, and those who wish a very full and detailed description of it will find it in the Report of Dr. Fitch above referred to. It belongs to the *Asilus* family of two-winged flies which have been very aptly termed the hawks of the insect world. Last July I found thse flies quite common in Mr. Shaw's beautiful gardens in St. Louis, and I watched them by the hour and found to my amazement that though other insects were flying all around, as well as other species of bees, yet they never seized any other species but the common Honey-bee. They capture the bee on the wing, pouncing upon it with lightning-like rapidity; then grasping it securely with their fore legs, they alight upon some plant or even upon the ground, and rapidly suck out the inside of the bee, with the stout and powerful proboscis which is shown in the figure, leaving the empty shell when they get through. Mr. Thompson says that beneath some favorable perch that is near the apiary, hundreds of these bee-shells may be found accumulated in a single day; while he has watched and found that a single fly on one of these perches destroyed no less than 141 bees in that period of time.

The habits of these flies are little known, and until they are better understood no feasible way of protecting the bees from their attacks can be given. Those which are known to haunt the apiary should be captured, and this can best be done by means of a net. It is almost impossible to catch them while on the wing, though as soon as they have settled with their prey they are caught with comparative ease. It will pay to thus catch them for they are doubtless the cause of much of the non-swarming which we hear of.

BENEFICIAL INSECTS.

I have already treated of a number of beneficial insects in connection with the insects on which they prey, and under this head I shall, for the present, only say a few words about

THE BEAR-HORSE, *alias* CAMEL-CRICKET, *alias* DEVIL'S RIDING HORSE—*Mantis Carolina*, Linn.

(Orthoptera Mantidæ.)

[Fig. 94.]

This peculiar and predatory insect which is variously known by either of the above names in different localities, is very fortunately quite common in the central and southern parts of Missouri, as well as in most of the Southern States. Its food consists mainly of flies, though it is a most voracious cannibal and will devour its own kind as well as any other living insect that comes within its grasp. I have known it to attack various kinds of butterflies, including the male Bag-worm, grasshoppers, and caterpillars of various kinds, and in one instance a single female devoured eleven living Colorado Potato-beetles during one night, leaving only the wing-cases and parts of the legs. It disdains all dead food, and never makes chase for the living, but quietly, patiently and motionless, it watches till its victim is within reach of its fore-arms, and then clutches it with a sudden and rapid motion. Its appearance is really formidable, and its attitude while watching for its prey quite menacing, and on this account it is held in very general and superstitious dread. It is, however, utterly incapable of harming any one; and, as one of our best friends should be cherished and protected.

At Figure 94, above, this insect is represented in the full grown state, *a* showing the female and *b* the male. It will be seen that they differ materially from each other, the male having a long slender body with long wings, while the female has a broad flat body with short wings. Hence, while the male can fly through the air with greater facility than do our grasshoppers, the female is utterly incapable of performing the same feat, and only uses her wings when in battle with one of her own kind, or when pouncing upon her prey, at which time she hoists them very much as a swan hoists his wings when irritated. The difference in the sexes is not apparent till after the third moult, all the young Mantes being very much alike. The general color of the Mantis is grayish-brown though a pale green dimorphous form is quite common. The newly hatched larva is invariably, so far as my observations extend, light yellowish-brown, though I have seen green individuals after the first moult. The green form is almost entirely confined to the female sex, and seems to be the most common color of this sex when full grown; but it is found likewise, to some extent, among the males, as specimens with green legs and partly green bodies are to be met with, though I have never seen a male that

[Fig. 95.]

was entirely green. About the beginning of August these Mantes acquire wings, and by the middle of September the female commences to deposit her eggs. These eggs are all glued tightly together in a peculiar mass, and are deposited in all sorts of situations, but principally on the twigs of trees. At Figure 95 two of these egg-masses are represented, natural size, the lower mass showing the most common form, the upper mass illustrating how it conforms to the object on which it is placed. These egg-masses are often found by persons in the winter, though very few are able to conjecture what they really are. On cutting them open the eggs are found to be very systematically arranged and to contain a mucilaginous substance of the color of thin glue.

The manner in which these eggs are deposited has never been described, and though I have never myself witnessed the operation, I have found the mass while it was yet quite soft and freshly laid, and have dissected the female just before she was about to deposit; and incline to believe that it is gradually protruded in a soft mucilaginous state, being covered at the time with a white, frothy, spittle-like substance which soon hardens and becomes brittle upon exposure to the air. Mr. Parker Earle informs me that he has witnessed the operation, and that he judges it to require about an hour, the eggs being "pumped out, and the entire mass elaborately shaped, with a fine instinct of construction as the process continues."

Between the 10th and 20th of June these eggs hatch into comical-looking little Mantes, in all respects resembling their parent, with the exception that they have no wings; for, with the grasshoppers, crickets, katydids, walking-sticks and roaches, etc., etc., which belong to the same order (*Orthoptera*), they do not undergo any sudden transitions from the masked *larva*, to the quiescent *pupa*, and thence to the winged *imago* state, as do most other insects.

When the young first issue from the egg-mass, they are yet, as with the young of most other *Orthopterous* insects, enveloped in a fine skin which confines their members and prevents free motion. In this condition they look not unlike some of our leaf-hoppers (*Tettigoniæ*,) but as soon as they extricate themselves they begin to show their unfeeling and voracious disposition by attacking and devouring each other. Indeed, those sentimentalists who believe that the worm crushed under foot suffers as much as the man who breaks an arm or a leg, would do well to study the habits of these Mantes. They are so void of all feeling that, the female being the strongest and most voracious, the male in making his advances, has to risk his life very many times, and at last only succeeds in grasping her by slyly and suddenly surprising her; and even then he frequently gets remorselessly devoured. I have seen a female, decapitated, and with her body partly eaten, slip away from another that was devouring her, and for over an hour afterwards fight as tenaciously and with as much *nonchalance* as though nothing had happened.

The eggs may be readily transported from one place to another, and the insect can thus be easily colonized. Mr. Jordon in this way has caused them to increase very much in his home nursery in St. Louis, though he finds some difficulty in protecting the eggs during the winter from the attacks of birds. He considers that as long as he can keep the Mantes sufficiently numerous he will never be troubled with noxious insects.

We know with what fear the hawk is regarded by the great majority of small birds, but that at the same time the common house martin defies and even tantalizes and drives it off. In like manner this Mantis which must be the dread of most flies, is yet defied by a certain class of them, belonging to the same (*Tachina*) family, as that described and figured on page 111, for I have found no less than nine maggots in the body of a living female Mantis, which must have hatched from eggs that had been deposited on her body by one of these flies.

INNOXIOUS INSECTS.

Under this head, I propose to devote a few pages each year to those insects which can neither be considered injurious or beneficial to man, either directly or indirectly. As State Entomologist I feel it my duty to devote my time primarily to the study of those insects that immediately concern the agriculturist, and by thus doing, to save to our great and growing State a portion of that immense sum which is annually lost by insect depredations. At the same time I feel that it will be expected of me to add to our present knowledge of the natural history of the State, by discoveries in my particular branch of zoology. The prosperity of a State does not depend solely on its material wealth, but to a great extent on its mental wealth. KNOWLEDGE —that great interpreter of oracles—moves the world! It enables us to see in the bowels of the unfathomable earth beneath, in the water, in the air, and in the skyey vast above, volumes written by the hand of Omnipotence!

> "To win the secret of a weed's plain heart,
> Reveals the clue to spiritual things,"

And there are few departments of science which offer such food for the mind as does the study of Natural History. It has been truly said that the naturalist has no time for selfish thoughts. Everywhere around him he sees significances, harmonies, chains of cause and effect endlessly interlinked, which draw him out of the narrow sphere of self-lauding into a pure and wholesome atmosphere of joy and felicity.

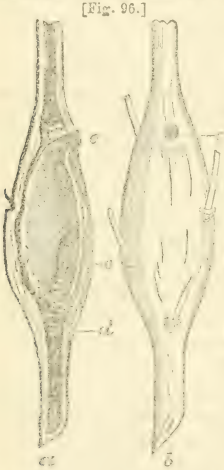
Day by day science is becoming more and more popularized, and before long the necessity of devoting more attention to natural history in our schools and colleges will become apparent. There are few things, for instance, so well calculated to train the minds of children, and at the same time entertain and instruct them as would be a chart illustrating the transformation of insects, and it is with the firm belief that this kind of information will soon be more generally sought for, that I introduce to my readers

THE SOLIDAGO GALL MOTH—*Gelechia gallæsolidaginis*, N. Sp. —Pl. 2, Figs. 1 and 2.

Every body must have noticed the large round galls about the size of a walnut which are found upon the straight smooth stem of the common Golden-rod (*Solidago nemoralis*). There are sometimes two on the same stalk and they are most conspicuous in winter time when the leaves are off the plant. Upon cutting open one of these galls it is found to consist of a pithy solid mass, in the centre of which is a plump white footless maggot. This maggot in due time develops into a two-winged fly, which was long since described by Dr. Fitch as *Trypeta (Acinia) solidaginis*.

The gall which I am now about to speak of, occurs on the same species of Solidago, and in almost equal abundance with the former, though its architect has never hitherto been described. This gall which is represented at Figure 96, *b*, is of a very different form from the preceding, being altogether more elongate and narrower, and upon cutting it open it is found to be hollow, and to contain, instead of a white footless maggot, a gray 16-footed caterpillar (*c*), which in time develops into the little moth which is represented with the wings expanded at Plate 2, Figure 1, and with the wings closed at Figure 2. The history of the insect may be thus briefly told.

[Fig. 96.]



The moths winter over and may be seen flying in the month of May, in which month I have myself captured a specimen. When the young plants of the Golden-rod are about six inches high the female moth deposits an egg either in the terminal bud, or at the side of the stalk just below it, and the worm hatching from the egg works into the stalk, and causes it to swell by gnawing and thus inducing the secretions towards it. By the beginning of June the gall has just begun to form and at this time upon cutting it open the worm is found to be about $\frac{1}{3}$ grown, and its excrement is as yet all at the upper portion of the gall. As the plant grows, so the gall increases in size, remaining, however, at the same altitude from the ground. By the middle of July both the gall and its maker have attained their full size, and upon opening the former at this season of the year the excrement will be found packed closely at both its ends, and from the small quantity of such excrement (*d*) to be found, it would appear that all but the more solid parts had been absorbed by the plant, it probably acting as a manure to stimulate the growth of the gall. When full grown, the worm measures rather more than half an inch, and it now prepares for changing into the chrysalis state by eating a perfectly round passage-way entirely through the wall of the gall at its upper end. It then protects the orifice with a secretion of liquid silk which hardens and forms a perfect little plug (Fig. 96, *c*,) about 0.04 thick and 0.08 in diameter, and which is so constructed that it cannot be readily displaced from without, as it has a rim on its outer edge. The inner edge, however, is not so rimmed, and the plug can be pushed away from the inside with the slightest effort, for the little tenant when it shall have become fitted to leave its dark and secluded tenement and soar into the air, must needs make its exit through this orifice. Well may we wonder at Nature's handiwerk, for what consummate skill, and wonderful instinct—I had almost said forethought—is here exhibited! Can this action be but a blind instinct, or has the larva a premonition of its future etherial imago state and its wants? Who can answer? Our little host, not satisfied with having thus protected the entrance to his home, now lines its passage way, and the walls, with a delicate silken tissue, after which he rests from his labors, and commences to undergo those mysterious transformations, so characteristic of his class. A gall cut in two at this stage of its growth presents the appearance of Figure 96, *b*. In two days' time the little worm has changed to a chrysalis, just ½ inch in length, rather slender and of a shiny mahogany-brown. At the end of about three weeks more the chrysalis grows very dark, and finally the inclosed moth bursts the skin and escapes from the gall.

The first moths usually appear about the middle of August, but as the time of egg-depositing covers a period of over a month, some of the moths have not left till the beginning of October. As winter approaches, the stem seems to grow weak above the gall, and usually bends and droops, while the gall itself shrinks and acquires a whitish weather-washed appearance. It is for these reasons, and from the gall being so near the ground that it does not attract the same attention as the large, round gall of the *Trypeta*.

I have been acquainted with this gall for six years, and have studied it closely during that time. It seems to occur quite generally over the country, and is especially abundant in the West. The first published account that I can find of it in this country is that given by Baron Osten Sacken, in the first volume of the Proceedings of the "Philadelphia Entomological Society," page 369, where he correctly describes it, as well as the puffed carcass of one of the caterpillars (Pl. 2, Fig. 5), caused by a parasitic *Chalcis* fly presently to be described; but he was not acquainted with the maker of the gall. The galls were received by him from Edward Norton, who resides at Farmington, Connecticut. They occur abundantly around Chicago, especially on the north side, in the old cemetery, which is now being converted into Lincoln Park. They are equally abundant around St. Louis, while I have found the same gall on the *Solidago Missouriensis* growing beyond Fort Kearney, in Nebraska, and even there the worm was attacked by the same parasitic *Chalcis* fly mentioned above.

The gall-making insects belonging to the same order (Lepidoptera) as our little moth, are by no means common, and the only other gall of this character with which I am acquainted, at all resembling the one just described, occurs on the stems of *Artemisia campestris* in France, and is produced by the larva of a very different little moth with pale yellow wings shaded with orange, first described by Herrich-Schæffer by the name of *Cochylis hilarana.* This last gall is figured on Plate 1, of the "Annales de la Société Entomologique de France" for 1856, and its history is detailed by M. E. Perris, at pages 33–58 of the same volume. The gall is similar in form, but narrower, with the walls thicker than that of my insect, while the larva is yellowish-white.

GELECHIA GALLÆSOLIDAGINIS, N. Sp.—*Larva.*—Length 0.60. Cylinderical. Color dark dull-brown, without shine. Largest on middle segments; tapering from 4th to head, and from 9th to extremity. Each segment impressed transversely in the middle, thus forming two folds, the thoracic segments having other such folds. Six small piliferous spots, two each side of dorsum and one above stigmata, which, together with the stigmata, are shiny and of a lighter brown than the body. Head and cervical shield light shiny-brown.

Chrysalis.—Length 0.50. Mahogany-brown. Form normal. Blunt at extremity.

Perfect moth.—Average length 0.38. Alar expanse ♀ 0 95, ♂ 0.75. Fore wings deep purplish-brown, more or less sprinkled with carneous. A light carneous band starts from the costa near the base, and curves towards the middle of the inner margin, which it occupies to a little beyond the beginning of the cilia, where it curves upwards towards the tip, reaching only half way up the wing. Here it is approached from above by a somewhat diffuse spot of the same color, which starts from the costa just behind the apex, and runs down to the middle of the wing.

In the plainly marked individuals there is an extra line running from the middle of the inner margin, outwardly obliquing to the middle of the wing, and then back to the inner margin a little beyond where the cilia commence, but in the great majority of specimens this mark is indistinct. Cilia light carneous. Hind wings slate-gray, with the cilia lighter. Antennæ finely annulated with the same two dark and light colors. Head, thorax and palpi light, with a sprinkling of the dark brown. Body dark, with light annulations, The species varies in the distinctness of its markings, and the light parts of the wing appear finely sprinkled with brown under the lens. Male generally smaller than female, with the antennæ proportionately a little longer.

Described from numerous bred specimens.

It seems to resemble *G. longifasciella* of Clemens, in coloration and pattern; but unfortunately our late lamented microlepidopterist, failed almost always to give the measurement of the species he described, and it is impossible to tell how much mine really resembles that species. Yet, as *longifasciella* was described from two mutilated specimens, received from A. S. Packard, jr., and as that gentleman has seen my insect and declared it an undescribed species, there can be little doubt of the fact.

Concealed within its gall, as this worm is, one would naturally suppose that it would rest unmolested from the outside world, and that no parasite could attack it through its green-walled fortress. Such however is not the case. Those oft-quoted lines, written in that spirit of ridicule, in the exercise of which Swift was always happy,

> "The little fleas that do so tease,
> Have smaller fleas that bite 'em,
> And these again have lesser fleas,
> And so *ad infinitum,*"

are as applicable to our gall-maker as to most other insects. There are indeed no less than six parasites which attack it, and from many hundreds of galls examined, I estimate that one worm out of every five is thus destroyed. As four of these parasites are new to science, and are all probably confined to this one species of insect, I will briefly describe them.

They all belong to the order HYMENOPTERA, and by far the most common of them is a little fly of a dark metallic green color, with reddish legs, which is represented highly magnified in Plate 2, Figure 6, the hair line below showing the natural size. Its larvæ infest the caterpillar in great numbers, and cause it to swell to three and four times its normal size. After they have absorbed all the juices of their victim, they form for themselves very fine brownish cocoons, which are so crammed together that they give the puffed-up worm the roughened appearance, shown at Plate 2, Figure 5, and prevent the skin from collapsing after they have left, so that it may be found within the gall at any time during the winter. These minute flies all leave the gall through a single minute hole, which must be made by one of their number. They are active little creatures, running nimbly, with their antennæ always bent towards the surface on which they travel. They have a wonderful power of jumping, and are able to leap the distance of a foot so suddenly and rapidly that they are, for the moment, scarcely visible. I have counted over 150 of them in a single caterpillar, and the mother fly must gnaw for herself a passage through the gall, and leisurely insert her batch of eggs in the inmate. This fly belongs to the *Chalcis* family, and may be called the Inflating *Chalcis* fly. The family to which it belongs has scarcely been at all studied in America, and very few species have been described. I therefore leave the species, for the present, undescribed, it apparently belonging to the genus *Pirene*.

Another parasite which infests this caterpillar, is represented in the perfect state at Plate 2, Figure 9, the hair line above showing the natural size. It is a black fly, and its larva, which is often found at the bottom of the gall during the month of August, is a white, footless grub, about 0.24 long, and attenuated at the head. Some of these maggots change to pupæ and become flies in the fall of the year, while others remain in the maggot state till spring. The pupa is whitish, with the members confined and darker. This fly belongs to the same (*Chalcis*) family as the preceding, and to the genus *Eurytoma*. I name it in honor of my esteemed friend, Mr. A. Bolter, of Chicago—an entomologist, as enthusiastic as he is modest, and an indefatigable collector. When I think of the many happy hours we have spent together, and recall our many pleasant hunting grounds, the following pretty lines are ever floating in my mind:

> "I long to walk by the meadow's brook,
> To visit the fields and the woods once more,
> To loiter long in the shady nook,
> And tread the paths I have trod before;
> Or, under the spreading branches to lie
> And watch the clouds in the azure sky."

Annexed will be found a full description of this parasite:

EURYTOMA BOLTERI, N. Sp.—♀ Length 0.18. Antennæ black, not much longer than the face, perceptibly thicker towards the end, and apparently 10-jointed, though the three terminal joints are almost always confluent. Dimensions and appearance of joints, represented in the annexed Figure 97, *a*. Head and thorax rough-punctured and finely bearded with short, stiff gray hairs. Abdomen about as long as thorax, scarcely so broad, viewed from above, but wider viewed laterally; highly polished, smooth and black, the three terminal segments with minute stiff gray hairs along the sutures; visibly divided into seven segments, the four anterior ones of about equal length, the two following shorter, and the terminal one produced into a point. Legs fulvous with the *coxæ*, thighs and more or less of the shanks blackish-brown. Wings perfectly transparent, glossy, colorless, and with the nerves very faint.

[Fig. 97.]

♂ Measures but 0.14, and differs in the antennæ, being twice as long as the face, in their narrowing towards the tip and in being furnished with whorls of long hairs. The number of joints are not readily made out, and I have consequently presented at Figure 97, *b*, a magnified figure. His body is but half as wide and half as long as the thorax viewed from above, and not quite as broad as the thorax, viewed laterally; it also lacks the produced point of the ♀. His wings are also cut off more squarely and more distinctly nerved.

The third parasite which attacks our gall-maker is represented somewhat enlarged at Plate 2, Figure 7. It is an opaque black fly belonging to the true ICHNEUMON family and apparently to the genus *Hemiteles*. After most of the gall-makers have undergone all their transformations and escaped, some few of the galls are found still ininhabited by the worm. These belated worms contain the larva of this fly, and they are somewhat smaller and paler than are the healthy ones; their life as worms being prolonged by the presence of their enemy within. During the month of September, the parasitic larva leaves the body of the caterpillar, and spins for itself, within the gall, a tough white silken cocoon, in which it remains through the winter, and from which the fly escapes during the following March or April, some of them escaping much earlier than others. This fly I have named in honor of my friend Mr. E. T. Cresson, of Philadelphia, to whom I am indebted for the generic determination of all these parasites.

HEMITELES (?) CRESSONII.—♂—Length 0.25. Black, opaque, head transversely-subquadrate; face clothed with pale glittering pubescence; spot on mandibles, palpi, scape of antennæ in front and the tegulæ, white; eyes large, ovate; antennæ longer than head and thorax, slender, black; thorax closely and minutely punctured; mesothorax with a deeply impressed line on each side anteriorly; scutellum convex, closely punctured, deeply excavated at base; metathorax coarsely sculptured, truncate and excavated behind, the elevated lines sharply defined, forming an irregularly shaped central area, and a triangular one on each side of it, the outer posterior angle of which is prominent and subacute; wings hyaline, iridescent, nervures blackish, stigma large, areolet incomplete, the outer nervure wanting; legs pale honey-yellow, coxæ paler, tips of posterior femora, and their tibiæ and tasri entirely blackish; abdomen elongate ovate, flattened, petiolated, the first segment flat, gradually dilated posteriorly, somewhat shining, and indistinctly longitudinally aciculate; the two following segments opaque, indistinctly sculptured; remaining segments smooth and shining.

A fourth parasite, belonging to the same great ICHNEUMON family, issues from the worm and spins a white silken cocoon, in exactly the same manner as the preceding. From this cocoon at the same season of the year, escapes a fly which is also of very much the same size and appearance, but which belongs to the distinct genus *Microgaster*.

It has hitherto been undiscribed and may be known by the specific name of *gelechia*.

MICROGASTER GELECHIA—Length 0.20 ♂ ♀.—Black, clothed with a short, thin, glittering, whitish pubescence, most dense on the face, which latter is closely punctured; occiput and cheeks shining; mandibles rufopiceous; palpi whitish; eyes pubescent; antennæ as long as the body in ♂, shorter in ♀, 18-jointed; thorax shining, feebly punctured, mesothorax closely and more strongly punctured, with a deeply impressed longitudinal line on each side over base of wings; scutellum smooth and polished, the lateral groove broad, deep, arched and crenulated; metathorax opaque, densely rugose, with a sharp, central, longitudinal carina, and a smooth, flat, transverse carina at base; tegulæ testaceous, wings hyaline, iridescent, apex smoky, nervures blackish, areolet complete, subtriangular, radial nervure indistinct; legs pale honey-yellow, coxæ blackish, pale at tips, middle pair in ♀ concolorous with legs; abdomen with the two basal segments densely rugose and opaque, the remainder smooth and shining; venter more or less varied with pale testaceous.

The galls containing worms that have been victimized by either of these last two parasites are generally small and narrow, indicating that the worm has been sickly and not able to perform its functions in a proper manner, but those containing worms infested with the Inflating Chalcis-fly, first described, are of the normal size, the worm often having completed its passage-way before succumbing to its enemy.

There are two other and larger parasites which attack our little Gall-maker, the one an undescribed species of *Pimpla* and the other an undescribed species of *Ephialtes;* making in all six distinct parasites. Besides these, there is another insect which intrudes upon and often kills him. This last is the larva of some small long-horned beetle, and most likely of some species of the genus *Oberea*, as it greatly resembles the larva of *Oberea ocellata*, Hald., which I have bred from the stems of the Cottonwood. After the parent gall-moth has deposited her egg, and the young worm and its gall have acquired considerable size, the parent beetle of this larva comes along and deposits her egg higher up on the same stem, and the larva hatching from it immediately commences boring downwards till it reaches the gall, where it riots until it has crowded out the proper inhabitant and filled the gall with excrementitious and pithy *debris*. It then continues its descent till it reaches the root, where it continues boring till winter approaches, and where it hybernates in the larva state. Sometimes the gall-maker succeeds in webbing this intruder out, so that he only partially destroys the gall, while at other times the intruder does not reach the gall till the inmate has changed to the chrysalis state; but in the latter case the moth always dies in its endeavors to escape. The vacated galls of this gall-moth afford excellent winter shelter for a variety of insects and spiders, and the common Chinch bug is especially fond of taking up its winter quarters in them.

THE CHICKWEED GEOMETER, *Hæmatopis grataria*, Fabr.—Pl. 2, Figures 18, 19, 20 and 21.

(Lepidoptera Geometridæ.)

At Plate 2, Figure 18, I have figured a very common little moth which may be seen flitting over our meadows and in our gardens during the summer and fall months. It is of a delicate orange color, marked with pink, as in the figure. A number of persons have desired to know whether or not it was injurious, and what its larva fed on, and, as its transformations have been hitherto unknown, I will briefly record them.

The female moths deposit their eggs in rows of about twenty, along the edge of a leaf, or along the stem of the common chickweed (*Stellaria media.*) These eggs (see Pl. 2, Fig. 21) are not quite 0.02 of an nch long and are oval, flattened and depressed near the centre. When first laid they are yellowish-white, but change within two days to a very bright, shiny, red color, between Venetian and vermillion. These eggs hatch in a very short time, frequently within a week, into thread-like worms, with ten legs only and with the habit of looping themselves into all manner of shapes, especially into a circle. In about a month, during hot weather, they acquire their full size, when they are of the form and appearance of Plate 2, Figure 19. They are quite variable in color, being either gray, yellowish-green, or dark brown. They change to chrysalids within a slight web attached to the leaves of their food-plant, and in this state they bear the appearance of Plate 2, Figure 20, the skin being so thin that before the moth escapes the colors of the wings show distinctly through it. There are several broods during the year, and the insect may often be found in all its different states at one and the same time. It probably passes the winter in either the larva or egg state, for I have taken both eggs and half grown larvæ in the beginning of November. In the larva and chrysalis state it is not easily detected, on account of its small size and of its assimilating the color of the food-plant. The larva has furthermore the habit of jerking itself away to a considerable distance when disturbed, especially while it is young.

HÆMATOPIS GRATARIA, Fabr.—*Larva*—Average length 0.85. Color quite variable; either pale yellowish-green, deep rufous with an orange tint, or of a mixture of gray and cream-color. Minutely punctate all over. Segments 1, 2 and 3, extremely short; 4, longest and widest, having two wrinkles each side, with a dark depression between them; 5, 6, 7 and 8, of equal length; 9, 10 and 11, short, the two former also somewhat wider than the other. Dorsum dark, with a lighter middle line, and a light, somewhat irregular subdorsal line which converges anteriorly and diverges posteriorly of each segment; two dark spots anteriorly each side of the middle line. Sides more or less wrinkled, lighter than dorsum and with a light longitudinal ridge below. Venter variegated with longitudinal marks, and shaded outwardly with deep olive-green in strong contrast with the lateral light ridge. Stigmata minute, black, and placed on an oval swelling at the anterior portion of the segment. Head of the same color as body, with a dark line, edged each side with white, continuing from the thoracic segments.

Chrysalis.—(Plate 2, Fig. 20.) Length, 0.50. Wing sheaths and tip of abdomen pale buff, the middle of the abdomen very light yellowish-green. A purplish dorsal line. Obliquely truncated at the head, having a somewhat triangular appearance, the ventral angle being lengthened into a slightly bifurcate snout. Anal segments quite attenuated, the extremity being also slightly bifurcated. Stigmata small, black and distinct.

THE THISTLE PLUME,—*Pterophorus carduidactylus*, N. Sp., Pl. 2, Figs. 13 and 14.

(Lepidoptera Alucitidæ.)

Having already sketched the history of the Grape Plume, page 137, the larva of which attacks the Grape vine, I will now give the history of another species of the same *genus* whose larva infests the common Thistle (*Cirsium lanceolata*) in order to show how very dissimilar two larvæ may be, which belong to the same genus and greatly resemble each other in the perfect state.

During the month of May the heads of the above named thistle may frequently be found drawn together by silken threads, with some of the leaves frequently dead. On pulling this webbed mass apart from eight to a dozen thick smooth worms may be found, which are of a light straw color with rows of black spots, and the head and tail

[Fig. 98.]

marked as in the accompanying figure. These worms are found of different sizes in the same head, which would indicate that the parent moth either deposits her eggs at different intervals in the same place or that the eggs hatch out irregularly. Towards the end of May they change to pupæ within the burrow which the worm inhabited; these pupæ being of a dull yellow color, without polish, and resembling the pupæ of some long-legged Crane fly (*Tipula*) rather than a moth—see Pl. 2, Fig. 14. In just one week after they have thus changed, the moths escape. This moth, which is represented at Plate 2, Figure 13, is of a tawny yellow color, with a prominent triangular dark spot on the outer third of the front wing, running from the front edge. As it differs from all hitherto described North American species, it may appropriately be called the Thistle Plume.

Pterophorus carduidactylus, N. Sp.—*Larva.*—Average length 0.60. Largest in the middle of body, tapering thence each way. Color light straw-yellow—greener when young. Somewhat darker, partly translucent, dorsal, subdorsal and stigmatal lines. Two lateral rows of black spots, the lower spots rather smaller and placed behind the upper ones. A third row above these, and others along the back, but so small that they are generally imperceptible with the naked eye, except on the thoracic segments, being especially distinct on segment 2. Head small, black, sometimes inclining to brown. Cervical shield black, divided longitudinally in the middle by a lighter line. Caudal plate also black. Segment 11, besides the spots above mentioned, has two transverse black marks, the posterior one the largest. Thoracic legs black, the others of the same color as the body.

Described from 12 specimens.

Pupa.—Average length 0.45. Of form of Plate 2, Figure 14. Soft, dull yellow, with a lateral dusky line, each side of dorsum, and another, less distinct each side of venter. Also dusky about the head and wing-sheaths.

Perfect insect.—Length 0.45; alar expanse 0.80. Front wings bifid, the cleft reaching not much more than ½ of wing; tawny yellow, with a distinct dark brown triangular spot running from costa to the base of cleft—sometimes a little below it—its posterior margin with a slight concave curve. Three dusky, diffuse longitudinal spots, one placed on the basal third of the wing at costa and frequently reaching along the costa to the triangular spot; one near the interior margin, a little nearer to the base of wing than the last, and one on the outer third of the interior margin. Two light-colored transverse lines across the end of wing, one very near and parallel with posterior margin, the other bordering the triangular spot behind, and curving across the lower lobe towards posterior angle. The space between these two light lines usually darker than the ground-color. Fringes dark with a light margin. Hind wings trifid, the upper cleft reaching a little beyond the middle, the lower one to the base of wing. Color ashy-brown, the lower lobe produced into a dark angular spot about their middle posteriorly. Antennæ, palpi, head, thorax, and body, tawny yellow; legs of the same color with the exception of the tarsi, which are almost white, with alternate dark brown spots, the spines being black, with dusky tips.

ERRATA.

Page 8, line 21, for "being" read "were."
Page 10, line 1, for "Figure 3, ♂" read "Figure 3, ♀."
Page 12, line 20, for "last" read "1866."
Page 12, line 3 from bottom, after "February," add "(1867)."
Page 31, line 15, for "37°" read "38°."
Page 47, line 16, for "far" read "for."
Page 114, line 1, after "insect" read "(*Strietrus frimbriatus*, Say)."
Page 120, line 30, after "Cottonwood" read "(*Pemphigus vagabundus*, Walsh)."
Page 133, line 24 from bottom, for "preceding insect" read "Grape curculio."
Page 134, line 3 from bottom, for "Part V" read "Part VI."
Page 142, under the heading, add "(Lepidoptera, Tortricidæ)."
Page 166, under the heading, add "(Lepidoptera, Tineidæ)."

INDEX.

SECOND ANNUAL REPORT

ON THE

Noxious,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
STATE ENTOMOLOGIST.

JEFFERSON CITY:
Horace Wilcox, Public Printer.
1870.

PREFACE.

To the Members of the Missouri State Board of Agriculture:

GENTLEMEN:—I herewith submit, for publication, my Second Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

For my First Report, I prepared two lithographic plates, a certain number of which were colored. Such plates, when well executed, are an adornment to any work, but they are expensive; and upon conferring with different members of the Board, it was thought best to furnish two such plates for one-half the edition, rather than one plate for the whole edition. The plan has not worked well, however, since many of those persons most interested in the Report, and for whom it is more especially designed, failed to get copies which had plates.

For this Second Report, therefore, I have confined the illustrations to wood. Most of these wood-cuts are executed in the best style of the art, but they cannot possibly show to good advantage on such paper as was used in last year's Report; and the pains taken in the preparation of these cuts, and in hiring the very best engravers the country affords, seems too much like waste of time and means, when their effect is so spoilt by poor ink and poorer paper. If it is in the power of the Board, by proper action, to secure a better quality of paper for this Report, I sincerely hope that such action will be taken; for a clear impression of an insect cut is often absolutely necessary, to enable the general reader to recognize, in the field, the living form of the particular species which it represents.

The cause of Economic Entomology lost one of its greatest champions, and the farmers and fruit-growers of the West, and especially of our sister State, Illinois, suffered an irreparable loss, in the sudden death, on November 18th, 1869, of Mr. Benj. D. Walsh, of Rock Island. At the time of his death, he was State Entomologist of Illinois, and my Associate in the Editorship of the *American Entomologist*, published at St Louis; and I hardly need say that this sad and unexpected fate of my friend has very much increased my own labors. When I add to this the fact that Mr. Walsh was prostrated for over three months last spring and summer, and that Mr. Wilcox, our State Printer, was ready for this Report at an earlier day than I had anticipated; you will not be surprised to learn that several subjects which I had contemplated treating of, have been unavoidably deferred another year.

In order to make the sense of the text plain to every reader, and at the same time to insure scientific accuracy, I shall continue to conform to the rules laid down in the introduction to my First Report—namely, to print all descriptions of merely scientific interest in small type; to use as far as possible a common name for each insect, always adding the scientific appellation in *italics* and parenthesis, so that it can be skipped, if necessary, without interfering in the least with the sense of the sentence; and to give the Order and Family to which each insect belongs, in parenthesis under each heading.

The reader will also bear in mind that the dimensions given, are expressed in inches and the fractional parts of an inch, 0.25 thus implying a quarter of an inch; and that the sign ♂ is an abbreviation for the word male, the sign ♀ for female, and the sign ⚲ for neuter.

My grateful acknowledgments are due to the Superintendents of the Missouri Pacific, South Pacific, Iron Mountain, Hannibal and St. Joseph, North Missouri, and Illinois Central Railroads for free passes over their respective routes.

All which is respectfully submitted by

CHARLES V. RILEY,
State Entomologist.

ST. LOUIS, MO., Dec. 2, 1869.

NOXIOUS INSECTS.

REPORT OF THE COMMITTEE ON ENTOMOLOGY.

READ BEFORE THE MISSOURI STATE HORTICULTURAL SOCIETY, AT ITS ELEVENTH ANNUAL MEETING, BY C. V. RILEY, CHAIRMAN OF THE COMMITTEE.

In the preparation of my Annual Report, I have dwelt in detail on many insects that have attracted attention during the year, either by their injuries or benefits. In that Report numerous illustrations will be used to appeal to the eye of the reader, and as it will be published in the same volume with your transactions, I deem it superfluous at the present time to dwell on the natural history of any one insect. Permit me, therefore, to cursorily refer to a few of the prominent entomological events of the year, and afterwards to make a few generalizations, which it is hoped will prove of some little interest and value.

The year 1869 may be set down as one in which our crops, as a general thing, have suffered less than usual from insect depredations. At least such has been the case in Missouri, and, judging from extensive correspondence, the same statement would hold true of most of the northern and middle States of the Union.

True, the Army-worm (*Leucania unipuncta*, Haw.), and the Grain Plant-louse (*Aphis avenæ*, Fabr.), appeared in many parts of the State in sufficient force to do considerable damage, and these two insects may always be expected in a tolerably wet year that was preceded by a very dry one. But most insects, and especially those which afflict you as horticulturists, have behaved exceedingly well, though it is difficult to say whether we are to attribute this good behavior on their part, to the increased knowledge of their habits which has been disseminated among those who have to deal with them, or to the more potent and unalterable workings of Nature.

The Chinch Bug, which in the dry summer of 1868, committed such ravages upon our grain crops in many portions of our State, and especially in the southwest, was scarcely heard of in 1869, after the copious rains which characterized the past summer commenced to shower down. The Apple Worm, or Codling Moth has been altogether less injurious than it was the year before, and in Adair, Buchanan, Cooper, Callaway, Cass, Lewis and Polk counties, especially, and probably all over the State, our orchards have been loaded with fair fruit. This result was predicted by the writer, and may be attributed principally to the scarcity of the insect, resulting from the partial failure of the apple crop in 1868; but in some part to the improved methods of fighting the foe. For, as in our civil strifes, we introduce improvements in the machinery which is to slay the opposing armies, so in this progressive age, we believe in introducing machinery to battle with our liliputian insect hosts, whenever it is available. And the experience of the past year proves, that to destroy this insect, old pieces of rumpled rag or carpet placed in the crotch of a tree, are to be preferred to the hay-bands wrapped around it, because it requires altogether less time to place the rags in their place than to fasten the hay-band; and the worms which spin up in them can be killed by wholesale, either by scalding the rags or by pressing them through the wringer of a washing machine.

Owing to the severe drouth of 1868, which was unfavorable to its successful transformations, that dreaded foe of the fruit-grower, the Plum Curculio, was scarce in the early part of the season, and our plum and peach trees set a fuller crop than they had done before for years; but the subsequent moist weather was favorable to the underground evolutions of this little pest, and the new brood appeared in great numbers about the end of June and beginning of July, when they did much damage to stone-fruit and some damage to pip-fruit by the gougings which they made for food. As stated in an essay read before the State meeting of our Illinois horticultural friends, I have discovered a little cannibal in the shape of a minute yellow species of *Thrips*, which destroys vast numbers of the "Little Turk's" eggs; and let us hope, that by attacking the Curculio in its most vulnerable point, this *Thrips* may in the course of a few years reduce the numbers of the Curculio, as the ladybirds have done with the Colorado Potato-bug, or as the minute mite (*Acarus mali*) is known to have done with the common Oyster-shell Bark-louse of the Apple. The eggs of the Apple-tree Plant-louse (*Aphis mali*) which last winter so thickly covered the twigs of the apple trees in many orchards, hatched and produced a prodigious number of lice as soon as the buds commenced to burst. In this immediate neighborhood they were soon swept away, however, by their cannibal insect foes, and by insectivorous birds, such as the warblers, etc.; but a physiological fact connected with this insect has been developed this year by Dr. E. S. Hull, the able Illinois State Horticulturist, which is of such importance that I cannot pass it over even in this brief report. He has ascertained that we suffer from the injurious punctures of their little beaks long after the lice themselves have disappeared. In fact, he has proved to his own satisfaction that the so-called "scab" in apples, which prevailed to such an alarming extent last year, and rendered thousands and thousands of bushels valueless for market purposes, is actually caused by the punctures of these lice. I said that the doctor had proved this matter "to his own satisfaction," because I believe that caution requires that we should not consider it as an established fact until all objections to it can be dispelled. Personally I have made no observations on this matter, but the facts in the case all add weight to Dr. Hull's theory, if such it can be called. Hitherto the cause of the "scab" on apples has been involved in mystery. It was supposed to have a fungoid origin; yet an examination will show that the scabby appearance is not caused by any live fungus, but by arrested growth of the cells which have become corky and cicatrized. The importance of this discovery of Dr. Hull's, should it once be firmly established, cannot well be estimated; for when we have once ascertained the cause of a disease, it need scarcely exist any longer. By destroying the lice we shall prevent scabby apples, and experience teaches that they can be destroyed by a good syringing of tobacco-water. We may expect, in this immediate vicinity, an almost total exemption from "scab" next year, for the apple trees are remarkably free from the minute black bead-like eggs of the Plant-louse with which they were so thoroughly peppered a year ago.

The Tent Caterpillar (*Clisiocampa Americana*) was more abundant than usual in our orchards, and the Tent Caterpillar of the Forest (*Clisiocampa sylvatica*) also appeared in great numbers both on our orchard and forest trees.

A worm which I have called the Pickle Worm, (*Phacellura nitidalis*, Cram.) and which had never been publicly noticed before, appeared in immense numbers, and did great damage to our cucumbers and melons by boring into the fruit, but as this insect, with others, will be fully treated of in my forthcoming Report, I will pass on to a more general subject.

> "The pebble in the streamlet scant,
> May turn the course of many a river;
> The dew-drop on the infant plant,
> May warp the giant oak forever."

In no department of science does the old proverb "prevention is better than cure," apply with such force as in that of Economic Entomology. In my studies and observations I have often been struck with the fact that many of our very worst insect enemies have been introduced from abroad, and that if this subject of Economic Entomology had been better understood and appreciated fifty years ago, and the proper measures had been taken to prevent the introduction of these pests, we should at present be free from the curse of the great majority of them. We have, indeed, plenty of Native American insects, which have become great pests to the cultivator of the soil, on account of the artificial state of things which he induces. In a state of Nature, a given species of plant, in its struggle for existence, is scattered promiscuously over a certain extent of country, and the particular insect or insects which feed upon that plant, have to search for it over a comparatively extensive surface, and their multiplication is consequently restricted. But the pursuit of horticulture, for instance—which may be succinctly defined as the assembling in tracts of greater or less extent, of one species of plant at the expense and exclusion of others—causes the particular insects which feed upon that plant, to multiply unduly, and we have to use that same intelligence in subduing these insects, which we employ in producing the artificial results which caused their increase. In the normal state of things insects never increase unduly; but, on the contrary, always act as Nature's most faithful servants, and accomplish a most important work in her economy. Yet, for reasons explained above, they naturally become our enemies, and we should suffer from the depredations of our indigenous species, even though no foreign ones had been imported. But we have altogether more than our share of these insect depredators, and so truly is this the case, that insects which attract universal attention, and are considered as very serious evils in Europe, would not be deemed worthy of notice in this country. There, if they lose one-fifth of a given crop, the whole community becomes alarmed; but here the cultivator sometimes considers himself fortunate if he secures the half of his crop from insect ravages, and each State loses annually from fifty to sixty million dollars from this cause alone, though but four States have as yet made any attempt to prevent this serious loss. In order to bring this fact home to you, and to show why we suffer more than do our foreign brethren, I will read a paper, which I have prepared for the *American Entomologist*, on

IMPORTED INSECTS AND NATIVE AMERICAN INSECTS.

If we examine into the history, as detailed in a recent number of our Magazine, (pp. 15–22) of the imported Currant Worm and the Native Currant Worm, we shall find a very curious state of things. These two insects both produce Sawflies, which are so closely allied to each other, that although they are referred to distinct genera by Entomologists, it may be doubted whether the genus (*Pristiphora*) under which the native species is classified be not a mere subgenus of that under which the imported species is classified. Reasoning *a priori*, therefore, we should expect to find a very great similarity in the destructive powers of these two worms, especially as each of them infests the leaves both of the Red Currant and of the Gooseberry. But what are the actual facts? On the one hand we see a Native American species—which must have existed here from time immemorial, feeding on our wild Gooseberries and perhaps on our wild Red Currant, and which yet has troubled our tame Gooseberries and tame Red Currants so very slightly, that it cannot be proved with absolute certainty to have ever done so at all, except in Rock Island county, Ills., and in Scott county, Iowa.*

On the other hand we see a species, only introduced into this country, from Europe, some twelve years ago, which has already almost put a stop to the cultivation of the Gooseberry and Red Currant throughout a large part of the State of New York, the northern borders of Pennsylvania, and the whole of Canada West, and is slowly but surely extending itself in all directions from the point where it was originally imported. What can be the reason of such a wide difference in the noxious powers of two such closely allied insects, feeding on exactly the same plants, but one of them indigenous to America and the other imported into America from Europe? Nor is this the only case of the kind. We can point out at least three other such cases. The Imported Onion-fly (*Anthomyia ceparum*), is a terrible pest to the onion-grower in the East, though it has not yet made its way out West. On the other hand, the Native American Onion-fly (*Ortalis arcuata*, Walker), which is a closely allied species and has almost exactly the same habits, has only been heard of in one or two circumscribed localities in the West, and even there does comparatively but little damage. Again, the Imported Oyster-shell Bark-louse (*Aspidiotus conchiformis*) is a far worse foe to the Apple and certain other fruit trees than our indigenous Harris's Bark louse, (*Asp. Harrisii*), though each of them infests the same species. Finally, the imported Meal-worm beetle (*Tenebrio molitor*) swarms throughout the whole United States, and is a great pest; while the Native American species (*Tenebrio obscurus*), which has almost exactly the same habits, belongs to the same genus, and is of very nearly the same size, shape and color, is comparatively quite rare among us, and is scarcely known to our millers and flour-dealers.

On a careful and close examination, it will be found that almost all our worst insect foes have been imported among us from the

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*In Volume 15 of the *Prairie Farmer*, page 504, a correspondent from Jefferson county, Iowa, states that as early as June 11th, in the year 1865, "a small green worm had taken the lion's share of his currants and gooseberries." This may possibly refer to the Native Currant Worm, which feeds upon gooseberry and currant leaves, but it more probably means the Gooseberry Fruit-worm (*Pempelia grossulariæ*, Packard,) which feeds upon the gooseberries and currants themselves, and which may be found figured and described in our First Missouri Report, page 140. What a vast fund of information is scientifically unavailable, simply because correspondents are so stingy with their pen, ink and paper. Again the editor of the *Farmers' Union*, published at Minneapolis, Minn., says in a recent number of that paper, that several gardens in that vicinity have been for the past few years infested with the Currant worm, and that last year they visited his own garden for the second time, having, the previous year, made sad havoc with the foliage before they were discovered. Now, as there are three perfectly distict worms which attack the leaves of currant bushes, and as the editor contents himself with referring to "THE Currant Worm," the information he imparts is perfectly valueless to the Entomologist, and the practical man may be led astray by the remedies suggested.

other side of the Atlantic. The Hessian Fly* was imported almost ninety years ago; the Wheat Midge about half as long ago; the Bee Moth at the beginning of the present century; the Codling Moth, the Cabbage Tinea, the Borer of the Red Currant, the Oyster-shell Bark-louse, the Grain Plant-louse, the Cabbage Plant-louse, the Currant Plant-louse, the Apple-tree Plant-louse, the Pear-tree Flea-louse, the Cheese-maggot, the common Meal-worm, the Grain Weevil, the House Fly, the Leaf-beetle of the Elm, the Cockroach, the Croton Bug, and the different Carpet, Clothes and Fur Moths, at periods which cannot be definitely fixed. Even within the last few years the Asparagus-beetle has become naturalized in New York and New Jersey, whence it will no doubt spread gradually westward through the whole United States, while the Rape Butterfly was introduced about a dozen years ago, and is rapidly spreading over some of the Eastern States. And only a year ago the larva of a certain Owlet-moth (*Hypogymna dispar*), which is a great pest in Europe, both to fruit-trees and forest-trees, was accidentally introduced by a Massachusetts entomologist into New England, where it is spreading with great rapidity. It is just the same thing with Plants as with Insects. We have looked carefully through Gray's *Manual of Botany*, and we find that—excluding from consideration all cryptogams, and all doubtful cases, and all cases where the same plant is supposed to be indigenous on both sides of the Atlantic—no less than TWO HUNDRED AND THIRTY-THREE distinct species of plants have been imported among us from the Old World, all of which have now run wild here, and many of which are the worst and most pernicious weeds that we have to contend against. In the United States *Agricultural Report* for 1865 (pp. 510–519) will be found a list of ninety-nine of the principal "Weeds of American Agriculture," by the late Dr. Wm. Darlington. Of this whole number no less than forty-three, or nearly one-half, are species that have been introduced among us from the Old World. Among these we may enumerate here, as the best known and the most pernicious, Butter-cups (two species), Shepherd's Purse, St. John's Wort, Cow-cockle, May-weed or Dog-fennel, Ox-eye Daisy, Common Thistle, Canada Thistle, Burdock, Plantain, Mullein, Toad-flax, Bind-weed, Jamestown (Jimson) weed, Lamb's Quarter, Smart-weed, Field Garlic, Fox-tail Grass and the notorious Cheat or Chess. And to these we may add the common Purslane, which, through some strange oversight, has been omitted in Dr. Darlington's catalogue.

It will be supposed, perhaps, since there are about as many voyages made from America to Europe as from Europe to America, that we have fully reciprocated to our transatlantic brethren the favors

*For the sake of the scientific reader, we subjoin here, in their regular order, the scientific names of the insects catalogued by their English names in the text of this paragraph: *Cecidomyia destructor, Diplosis tritici, Galleria cereana, Carpocapsa pomonella, Plutella cruciferarum, Ægeria tipuliformis, Aspidiotus conchiformis, Aphis avenæ, A. brassicæ, A. ribis, A. mali, Psylla pyri, Piophila casei, Tenebrio molitor, Sitophilus granarius, Musca domestica, Galeruca calmariensis, Blatta orientalis, Ectobia germanica, Tinea tapetzella, vestianella, pellionella, &c.; Crioceris asparagi, Pieris rapæ and Hypogymna dispar.*

which they have conferred upon us, in the way of Noxious Insects and Noxious Weeds. It is no such thing. There are but very few American insects that have become naturalized in Europe, and even these do not appear for the most part to do any serious amount of damage there. For example, on one or two occasions single specimens of our Army-worm Moth (*Leucania unipuncta*) have been captured in England; but the insect has never spread and become ruinously common there, as it continually, in particular seasons, does in America. Our destructive Pea-bug (*Bruchus pisi*) has also found its way to Europe; but although it is met with in England, and according to Curtis has become naturalized in the warmer departments of France, Kirby and Spence expressly state that it does not occur in England "to any very injurious extent," and Curtis seems to doubt the fact of its being naturalized in England at all.* Again, the only species of White Ant that exists within the limits of the United States, (*Termes frontalis*), has been known for a long time to be a guest at the Plant-houses of Schönbrunn, in Germany; but is not recorded to have ever as yet spread into the surrounding country. As to our American Meal-worm (*Tenebrio obscurus*), Curtis states that it has been introduced into England along with American flour, and that it is sometimes abundant in London and the provinces;† but Kirby and Spence say not one word about it, and it seems to be confined to the English sea-ports and the places where American flour is stored, without spreading into the adjacent districts.

A very minute yellow ant, however, (*Myrmica molesta*), which is often very troublesome with us in houses, has, according to Frederick Smith, "become generally distributed and naturalized" in houses in England; and Kirby and Spence state more specifically, that "it has become a great pest in many houses in Brighton, London and Liverpool, in some cases to so great an extent as to cause the occupants to leave them."‡ As to our Chinch Bug, our Curculio, our Plum Gouger, our two principal Apple-tree Borers, our Canker-worm, our Apple-tree Tent-caterpillar, our Fall Web-worm, our Peach-tree Borer, and our other indigenous pests among the great Army of Bad Bugs, nobody ever yet found a single one of them alive and kicking on the other side of the Atlantic. And with regard to Plants, the only two American plants that we know to have become so firmly established in Europe as to be a nuisance there, are an American aquatic plant, the common Water-weed (*Anacharis canadensis*), which has choked up many of the canals in England, and our common Horse-weed, or Mare's tail as it is called in the West, (*Erigeron canadense*), which has spread from America nearly over the whole world.

Since then, it can be demonstrated by hard, dry facts, that American plants and insects do not become naturalized in the Old World

*Kirby & Spence *Introd.* Letter 6th; Curtis *Farm insects*, p. 358.

†*Farm insects*, p 334.

‡Smith in Stainton's *Entom. Annual* 1862, p. 70, and 1863 pp. 59–62; Kirby & Spence *Introd.*, Letter 8th.

with anything like the facility with which the plants and insects of the Old World are every day being naturalized in America, there must be some cause or other for this singular state of things. What is that cause? It is, as we believe, a simple fact which is pretty generally recognized now as true by modern naturalists, namely, that the plants and animals of America belong, as a general rule, to an old-fashioned creation, not so highly improved and developed as the more modernized creation which exists in Europe. In other words, although this is popularly known as the New World, it is in reality a much older world than that which we are accustomed to call the Old World. Consequently, our plants and animals can no more stand their ground against European competitors imported from abroad, than the Red Indian has been able to stand his ground against the White Caucasian Race. On the other hand, if by chance an American plant or an American animal finds its way into Europe, it can, as a general rule, no more stand its ground there against its European competitors, than a colony of Red Indians could stand their ground in England, even if you gave them a whole county of land and an ample supply of stock, tools, and provisions to begin with. For throughout Animated Nature, as has been conclusively shown by Charles Darwin, there is a continual struggle for existence, the stronger and more favorably organized species overpowering and starving out from time to time their less vigorous and less favorably organized competitors. Hence, it is as hopeless a task for a poor puny, old-fashioned American bug to contend against a strong energetic, highly-developed, European bug, as it would be for a fleet of old-fashioned wooden ships to fight against a fleet of our modern iron-clads.

Let not "Young America," however, be altogether discouraged and disgusted at hearing, that our Animal and Vegetable Creation is more old-fashioned than that of what is commonly known as the Old World. The oldest geological formations, in which the remains of Mammals occur, contain the remains of such mammals exclusively (*Marsupialea*) as bring forth their young only partially developed, and carry those young about with them in a pouch, till the day of complete development and physical "second birth" arrives. In America we have a single genus—the Opossums—that belongs to this antediluvian type. In the three ancient continents they have absolutely none at all. But if in this respect America is more old-fashioned than Europe, Australia is still more old-fashioned than America; for there almost all their mammals possess this remarkable peculiarity; so that if the American creation is somewhat old-fogyish, that of Australia is the very concentrated essence of old-fogyism itself. Consequently, if Europe crows over us as altogether "behind the times," "Young America" can take its revenge by crowing over Australia, as the land of the Kangaroo and the Wombat and other such exploded absurdities of the Mesozoic epoch.

The theory advanced in the above paper, may meet with some objectors, although I confidently believe in the inference there stated of the relative advancement and improvement of the flora and fauna of the two continents. But there is another reason why the insects which are imported into this country multiply at a prodigious rate, and soon acquire herculean power of doing harm, though they may never have stepped beyond the limits of propriety in their own native home—a reason too palpable and evident to savor of the theoretical. It is, that whenever an injurious insect is introduced in our midst, as a general rule the particular parasite or parasites which kept it in check abroad, are not introduced with it. In consequence, the foreigners, unaccompanied by the usual *gens d'armes*, throw off all restraint and play the deuce with our crops; just as the rats and mice will take possession of, and overrun a house, if not restrained by human or by feline agencies.

Sometimes, as in the case of the Imported Currant-worm, the noxious insects introduced from the old world are attacked by native American parasites, but as I believe the parasites of European nativity to be, as a rule, more energetic and vigorous than our indigenous ones, it would be advisable even in such a case, to import in addition such species as prey upon it in Europe. But in the case of the Wheat Midge which has actually flourished among us for almost half a century without a single parasite of any kind whatever infesting it from one end of the country to the other, it is sheer folly and cupable shiftlessness not to import among us from the other side of the Atlantic some one or all of the three different *Chalcis* flies which are known to check it throughout all Europe. And so with other insects which are known to be unaccompanied with the parasites which attack them abroad. Years and years ago Dr. Fitch demonstrated in print the policy of such a step; but bugs and bug-hunters are so very generally the subject of festive ridicule among the high and low vulgar, that hitherto the recommendation of the State Entomologist of New York has met with no practical response.

Now no one will fail to understand the force of the old proverb already quoted, after listening to these facts. Let us profit by the experience of the past, and while battling with those foes which are already in our midst, let us keep a watchful eye, and be on our guard ready to crush any new plague that may threaten us, before it gets beyond control. Yes, but say you, how is this to be accomplished? Can it be done by the government? Yes, in some cases; as for instance in the importation of parasites, government aid should be solicited. If, in 1860, when the Asparagus Beetle (*Crioceris asparagi*, Linn.) was first introduced on to Long Island, the Legislature of the State of New York had taken proper action in the matter, the insect might have been stamped out of the island at the trivial expense of a few hundred dollars, instead of being allowed to multiply, as it did, to such an extent as to occasion a dead loss of some fifty thousand dollars in a single county, and of spreading from the island into the adjoining country. Quite recently a weevil (*Bruchus granarius*) which does immense damage to peas and beans and some other plants in Europe, was introduced into New York in some pods which a certain gentleman presented to the New York Farmers' Club, and if the proper steps are at once taken, it may yet be prevented from spreading through the country.

In Europe vast sums have been expended in founding professorships of Economic Entomology in the various agricultural colleges, and in conducting elaborate experiments on the best means of checking and controlling these tiny foes. But the entire sum expended by Congress or by our various State Legislatures for this purpose, from the Declaration of Independence to the year of our Lord 1869, cannot exceed ninety or one hundred thousand dollars, or about one thousand dollars a year. Yet the annual damage done by insects within the limits of the United States cannot be less than three hundred million dollars. Indeed, it is but quite recently that the people, from necessity, have awakened to the importance of the subject. We now have an Entomologist connected with the Department of Agriculture at Washington, and, with proper care, he can be of inestimable service to the country, in preventing the introduction of noxious insects. It is not noxious weeds alone, such as the Canada thistle, which are sent broadcast over the land by the distribution of uninspected seeds; but noxious insects are very frequently distributed in the same way. We have the highest authority, Dr. J. L. LeConte, of Philadelphia, for the statement, that before the Entomologist received his appointment, a noxious beetle, *Rhizopertha pusilla*, which has now become naturalized here, was originally introduced into this country in wheat from the Patent Office.

Therefore, there can be no doubt that much may be done at headquarters. That government aid cannot be of any avail in the great majority of instances, however, is equally apparent to those who have studied this question; and we must trust to a more thorough dissemination of such information as will enable each individual to protect himself. Much is being done in this direction by means of State Reports, through the *American Entomologist*, and through our various agricultural and horticultural journals; but much yet remains to be done. We must bear in mind that by enlightening our neighbors, we are helping ourselves, and, as horticulturists, we should urge that more attention be paid in our colleges, and especially in those of an Industrial nature, to the study of the Natural Sciences.

In my First Report, I have shown how the Oyster-shell Bark-louse, though perfectly able to live in the northern part of this State, is yet unknown there; and I tremble, lest some one in carelessness or ignorance should, introduce this dreaded plague of the apple grower into that section, from some Eastern or Northern nursery. Every tree received from a distance should be examined from "top to stern," as the sailors say, before it is planted, and all insects, in whatever state they may be, destroyed. There can be do doubt that many of our worst insect foes may be guarded against by these precautions. The Canker-worm, the different Tussock-moths or Vaporer-moths, the Bark-lice of the Apple and of the Pine, and all other scale insects (*Coccidæ*), the Apple-tree Root-louse, etc., are continually being transported from one place to another, either in earth, on scions, or on the roots, branches, and leaves of young trees; and they are all possessed of such limited powers of locomotion, that unless transported in some such manner, they would scarcely spread a dozen miles in a century.

In the Pacific States, fruit-growing is a most profitable business, because they are yet free from many of the fruit insects which so increase our labors here. In the language of our late lamented Walsh, "although in California the Blest, the Chinese immigrants have already erected their joss houses, where they can worship Buddha without fear of interruption, yet no 'Little Turk' has imprinted the crescent symbol of Mahometanism upon the the Californian plums and the Californian peaches." But how long the Californians will retain this immunity, now that they have such direct communication with infested States, will depend very much on how soon they are warned of their danger. I suggest to our Pacific friends that they had better "take the bull by the horns," and endeavor to retain the vantage ground they now enjoy. I also sincerely hope that the day will soon come when there shall be a sufficient knowledge of this subject throughout the land, to enable the nation to guard against foreign insect plagues; the State against those of other States, and the individual against those of his neighbors.

THE CHINCH BUG—*Micropus leucopterus*, Say.

(Heteroptera, Lygæidæ.)

[Fig. 1.]

a

Few persons will need to be introduced to this unsavory little scamp, but, lest perchance, an occasional reader may not yet have a clear and correct idea of the meaning of the word Chinch Bug, I represent herewith (Fig. 1) a magnified view of the gentleman. The hair-line at the bottom shows the natural size of the little imp, and his colors are coal-black and snow-white. He belongs to the order of Half-winged Bugs (HETEROPTERA), the same order to which the well known Bed Bug belongs, and he exhales the same loathsome smell as does that bed-pest of the human race. He subsists by sucking, with his sharp-pointed beak, the juices of our cereals, thereby causing them to shrink and wither, and not by gnawing or biting their substance, as many persons suppose. Insignificant as is the minute puncture of a single individual, yet these insects often appear in such countless numbers as to bleed to death whole fields of grain by their myriad beaks.

If the Western Fruit-grower is asked, what particular insect is the most difficult for him to combat, and the most destructive to his crops, he will probably answer "The Curculio." If the same question is put to the Western Grain-grower, he will infallibly reply "The Chinch Bug." And he will be in the right. The Wheat-midge—popularly known in the West as the "Weevil" or the "Red Weevil"—does a considerable amount of damage, in particular years and in particular localities, by its little legless orange-colored lava sucking away the sap from the growing kernel of wheat. The Hessian Fly—often called simply "the Fly"—injures the wheat by the maggot that produces it living between the stem and the sheath of the blade, and intercepting the sap before that sap can reach the ear. The Grain Plant-louse, easily distinguished from the above two little pests by its long sprawling legs, has in certain years somewhat injured the small grain in the West by accumulating, first on the growing stem and afterwards on the ear, and abstracting the sap with its long pointed beak. There are also, in all probability, several minute Two-winged Flies, which do more or less injury to the growing grain by their larvæ breeding in the stem, the natural history of one of which, the American Meromyza, was given for the first time in my First Report (pp. 159–61). The larva of an unknown moth, which burrows upwards and downwards in the stem of oats, and probably of wheat also, causing the ear to become prematurely white and the kernel to be entirely blasted, also in some years does considerable damage. The White Grub, the Wire-worm, and certain Cut-worms take a certain per centage of the young grain, almost as soon as it peeps out of the ground. But undoubtedly the meanest bug, out of the whole crowd of the multifarious insect-foes of the grain-growing farmer, is the Chinch Bug. He is not satisfied with taking a field here and a field there, and sparing the remainder. But when his time comes—and in mercy to the Western Farmer we are not cursed every year with this little savage—he sweeps the whole country with the besom of destruction. The Wheat-midge, the Hessian Fly, and the Grain Plant-louse, destructive as they are to small grain, yet spare our corn. If they take the good white wheaten bread out of our mouths, they yet leave us an ample supply of corn-dodgers. But the Chinch Bug makes a clean sweep, whenever he gets the upper hand of us. He "goes the entire hog." Nothing in the way of grain comes amiss to him. He is not dainty, not he! Whenever he gets a chance to spread himself, he first of all at one fell swoop destroys the small grain, and then fastens his liquorish beak upon the corn and takes that also.

PAST HISTORY OF THE CHINCH BUG.

The first record we have of the prevalence of the Chinch Bug was in the old Revolutionary times in North Carolina, where it was confounded with the Hessian Fly, an insect just then imported from Europe into the United States. Ever since those times it has been an epidemic pest, in particular years, in North and South Carolina and in Virginia. The great American entomologist, Thomas Say, in 1831, when he had been residing in Indiana for six years, was the first to name and describe it scientifically. He states that he "took a single specimen on the Eastern shore of Virginia;" whence we may reasonably infer that it was then either unknown or very rare in Indiana, and probably also in the other Western States. In Missouri it did considerable damage as early as 1854, for Jas. Pleasant of Fox Creek, St. Louis county, informed me that he had known it since that year, and that he had been previously acquainted with it in Virginia. Wm. M. Beal of Edina, Knox county, writes that it has existed and done more or less damage there since 1856, though it has scarcely been heard of since 1865. Mr. A. H. Roberts of Gray's Summit, Franklin county, informs me that it has not been in that neighborhood more than eight or ten years, and Mr. C. S. Jeffries, of Boles' post office in the same county, never heard of it till about fifteen years ago, though he has lived there for the last fifty years.

If proper records existed, we should doubtless find that it attracted attention in Missouri at a much earlier day, for in Illinois it was noticed as long back as 1840, in Hancock county, where it was absurdly supposed to have been introduced by the Mormons of Nauvoo, and was called the "Mormon louse"

In 1868, owing to the great drouth, this insect, as I have stated elsewhere, was quite injurious in many sections of our own State, and especially in the southwest. In the extreme northern portion they began to attract attention about the first of May, but the wet weather that occurred about that time caused them to disappear. In the more central counties the earliest sown wheat suffered but little from their depredations, though that which was sown later, was reduced about one-third. The conditions being favorable, they rapidly increased during the Summer, and in the fall, the second brood was so numerous that great fears were entertained for the safety of the crops of 1869. Let us be thankful, however, that the excessive rains of last spring and summer, though deplored and regretted by many, had the effect to so thoroughly drown out these little pests, as to make them comparatively harmless; for the only place in which I heard of their doing serious harm was at Tinney's Grove in Ray county. Seeming misfortune is often a blessing in disguise, and though the corn crop was lessened by the heavy rains, the wheat crop in all probability would have suffered far worse, had the season been dry and favorable to the increase of this, the greatest insect foe of the wheat-grower.

We may safely conclude that the Chinch Bug has always existed in Missouri, in small numbers; but that it did not multiply to an injurious extent until the grains began to be cultivated on an extensive scale. At all events, we know from the evidence of Dr. Harris and Dr. Fitch, that it existed long ago in exceedingly small numbers in New York, and even in Massachusetts. What the causes may have been, that thinned out the numbers of this insect in former times in the West, is another question. In former times, the great bulk of these bugs were probably destroyed every winter by the prairie fires, and, as cultivation has extended in consequence of the country being gradually settled up, and less and less prairie has been annually burnt over, the number that has survived through the winter to start the next year's broods has annually become greater. If these views be correct, we may expect them, unless more pains be taken to counterwork and destroy them, to become, on the average of years, still more abundant than they now are, whenever prairie fires shall have become an obsolete institution; until at last Western farmers will be compelled, as those of North Carolina have already several times been compelled, to quit growing wheat altogether for a term of years.

It may be very reasonably asked, why the Chinch Bug does not increase and multiply in Massachusetts and New York, seeing that it existed there long ago, and that there are, of course, no prairie fires in those States to keep it in check. The answer is, that the Chinch Bug is a Southern, not a Northern species; and that hundreds of Southern species of insects, which on the Atlantic seaboard only occur in southerly latitudes, are found in profusion in quite a high latitude in the Valley of the Mississippi. The same law, as has been observed by Professor Baird, holds good both with Birds and with Fishes.*

NATURAL HISTORY OF THE CHINCH BUG.

In the four great and extensive Orders of Insects, namely, the Beetles (*Coleoptera*), the Clear-winged Flies (*Hymenoptera*), the Scaly-winged Flies (*Lepidoptera*), and the Two-winged Flies (*Diptera*), and in one of the four small Orders in its restricted sense, namely, the Net-winged Flies (*Neuroptera*), the insect usually lies still throughout the pupa state, and is always so far from being able to eat or to evacuate, that both mouth and anus are closed up by membrane. In the remaining three small Orders, on the contrary, namely, that of the Straight-winged Flies in its most extensive sense (*Orthoptera* including *Pseudo-neuroptera*), the Half-winged Bugs (*Heteroptera*) and the Whole-winged Bugs (*Homoptera*), the pupa is just as active and just as ravenous as either the larva or the perfect

* Silliman's Journal, xli, p. 87.

insect, and the little creature never quits eating as long as the warm weather lasts, except for a day or so while it is accomplishing each of its successive three, four or five moults. As the Chinch Bug belongs to the Half-winged Bugs, it therefore continues to take food, with a few short intermissions, from the day when it hatches out from the egg to the day of its unlamented death.

Most insects—irrespective of the Order to which they belong—require 12 months to go through the complete circle of their changes, from the day that the egg is laid to the day when the perfect insect perishes of old age and decrepitude. A few require 3 years, as for example the Round-headed Apple-tree Borer (*Saperda bivittata*, Say) and the White Grub which produces the May-beetle (*Lachnosterna quercina*, Knoch.) One species, the Thirteen-year Locust (*Cicada tredecim*, Riley), actually requires 13 years to pass from the egg to the winged state; and another, the Seventeen-year Locust (*Cicada septemdecim*, Linn.) the still longer period of 17 years. On the other hand there are not a few that pass through all their three states in a few months, or even in a few weeks; so that in one and the same year there may be 2, 3 or even 4 or 5 broods, one generated by the other and one succeeding another. For example, the Hessian Fly (*Cecidomyia destructor*, Say), the common Slug-worm of the Pear (*Selandria cerasi*, Peck), the Slug-worm of the Rose (*Selandria rosæ* Harris), the Apple-worm and a few others, produce exactly two generations in one year, and hence may be termed "two-brooded." Again, the Colorado Potato-beetle in Central Missouri is three-brooded, and not improbably in more southerly regions is four-brooded. Lastly, the common House-fly, the Cheese-fly, the various species of Blow-flies and Meat-flies, and the multifarious species of Plant-lice (*Aphis*) produce an indefinite number of successive broods in a single year, sometimes amounting in the case of the last-named genus, as has been proved by actual experiment, to as many as nine.

As long ago as March, 1866, I published the fact that the Chinch Bug is two-brooded in North Illinois (*Practical Entomologist*, I, p. 48), and I find that it is likewise two-brooded in this State. and most probably in all the Middle States. Yet it is quite agreeable to analogy that in the more Southern States, it may be three-brooded. For instance, the large Polyphemus Moth is single-brooded in the Northern and Middle States, and yet, two broods are sometimes produced in this State, while in the South it is habitually two-brooded. Again, the moth known as the Poplar Spinner, (*Clostera Americana*, Harris), is stated by Dr. Harris and Dr. Fitch to be only single-brooded in Massachusetts and New York, the insect spinning up in September or October, passing the winter in the pupa state, and coming out in the winged form in the following June. But Dr. Harris—no doubt on the authority of Abbott—states that "in Georgia this insect breeds twice a year;"* and I have proved that it does so breed in Missouri, having

Injurious Insects, p. 434.

now (Dec. '69) a number of cocoons which were formed by a second brood of larvæ. It is quite reasonable, therefore, to infer that the Chinch Bug may produce even more than two broods in the more Southern States.

It is these two peculiarities in the habits of the Chinch Bug, namely, first, its continuing to take food from the day of its birth to the day of its death, and secondly, its being either two-brooded or many-brooded, that renders it so destructive and so difficult to combat. Such as survive the autumn, when the plants on the sap of which they feed are mostly dried up so as to afford them little or no nourishment, pass the winter in the usual torpid state, and always in the perfect or winged form, under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass or weeds or straw, and often in corn-stalks and corn-shucks. In the fall and winter of 1868, I repeatedly received corn-stalks that were crowded with them, and it was difficult to find a stalk in any field that did not reveal some of them, upon stripping off the leaves. I have even found them wintering in the gall made by the Solidago Gall-moth (*Gelechia gallæsolidaginis*), described in the First Report.

In the winter all kinds of insect-devouring animals, such as birds, shrew-mice, etc., are hard put to it for food, and have to search every hole and corner for their appropriate prey. But no matter how closely they may thin out the Chinch Bugs, or how generally these insects may have been starved out by the autumnal droughts, there will always be a few left for seed next year. Suppose that there are only 2,000 Chinch Bugs remaining in the spring in a certain field, and that each female of the 2,000, as vegetation starts, raises a family of only 200, which is a low calculation. Then—allowing the sexes to be equal in number, whereas in reality the females are always far more numerous than the males—the first or spring brood will consist of 200,000, of which number 100,000 will be females. Here, if the species were single-brooded, the process would stop for the current year; and 200,000 Chinch Bugs in one field would be thought nothing of by the Western farmer. But the species is NOT single-brooded and the process does NOT stop here. Each successive brood increases in numbers in Geometrical Progression, unless there be something to check their increase; until the second brood amounts to twenty millions, and the third brood to two thousand millions. We may form some idea of the meaning of two thousand millions of Chinch Bugs, when it is stated that that number of them, placed in a straight line head and tail together, would just about reach from the surface of the earth to its central point—a distance of four thousand miles.

According to the reasoning of Dr. Henry Shimer, of Mt. Carroll, Illinois, who published an interesting paper on this insect in the proceedings of the Academy of Natural Science of Philadelphia for May, 1867, the Chinch Bug takes wing only at its love seasons, which occur in his locality in May and in August. His views on this subject are well set forth in the following paragraph taken from the paper above alluded to:

May 16, 1865, was a delightful, mild, bright, sunny, summer-like day: and I again, for the last time, observed the same highly interesting phenomena, which I have noticed above as occurring after the harvest of 1864—the atmosphere swarming with Chinch Bugs on the wing. This is their spring; that was their autumnal nuptial season—their season of love. These remarkable little creatures prefer to conduct their courtships under the searching gaze of the noonday sun, instead of at the midnight hour. They were so numerous, alighting on the pavements in the village, that scarcely a step could be taken without crushing many of them under foot. In a few days, they had all disappeared; their breeding grounds were chosen, where they could be found in great numbers, often in pairs. I first noticed this disposition of the Chinch Bug to take wing under the promptings of the love passion, about six years ago, in their autumnal love season. At no other time save their love season, twice a year, have I ever seen one Chinch Bug flying. It is quite remarkable that the winged imago, under no other circumstances will even attempt to use its ample wings. No threatening danger, however imminent, whether of being driven over by grain reapers, wagons, or of being trodden under foot, etc., will prompt it to use its wings to escape. I have tried all imaginable ways to induce them to fly, as by threshing among them with bundles of rods or grass, by gathering them up and letting them fall from a height, etc., but they invariably refuse entirely to attempt to use their wings in escaping from danger. The love emotion alone makes them conscious that they are in possession of wings.

I agree entirely with Dr. Shimer as to the facts mentioned in the paragraph, but not as to the conclusions which he deduces. There are many objections to his theory, some of which may be found in the *American Entomologist*, (Vol. I, pp. 172–3).

It is a notorious fact that Chinch Bugs do not all mature at once, and if they took wing only when making their courtships, some of them would be flying during a period of several weeks; and as will be shown presently, there exists a dimorphous short-winged form of the Chinch Bug, which cannot possibly make any such ærial love trips. It seems more agreeable to analogy that they take wing only when they have become so unduly numerous that they are instinctively aware that they must either emigrate or starve. Be this however as it may, the fact of their being as a general rule unwilling to use their wings is well known to every practical farmer.

It has long been known that the Chinch Bug deposits its eggs underground and upon the roots of the plants which it infests, and that the young larvæ remain underground for some considerable time after they hatch out, sucking the sap from the roots. If, in the spring of the year, you pull up a wheat plant in a field badly infested by this insect, you will find hundreds of the eggs attached to the roots; and at a somewhat later period the young larvæ may be found clustering upon the roots and looking like so many moving little red atoms. The egg is so small as to be scarcely visible to the naked eye, of an oval shape, about four times as long as wide, of a pale amber white color when first laid, but subsequently assuming a reddish color from the young larva showing through the transparent shell.* As the mother Chinch Bug has to work her way underground in the spring of the year, in order to get at the roots upon which she proposes to lay her eggs, it becomes evident at once, that the looser the soil is at this time of the year the greater the facilities which are offered for the operation. Hence the great advantage of ploughing land for spring grain in the preceding autumn, or, if ploughed in the spring, rolling it repeatedly with a heavy roller after seeding. And hence the remark frequently made by farmers, that wheat harrowed in upon old corn-ground, without any ploughing at all, is far less infested by Chinch Bug than wheat put in upon land that has been ploughed. There is another fact which has been repeatedly noticed by practical men. This insect cannot live and thrive and multiply in land that is sopping with water; and it generally commences its operations in early spring upon those particular parts of every field where the soil is the loosest and the driest.

The female occupies about three weeks in depositing her eggs, and, according to Dr. Shimer's estimate, she deposits about 500. The egg requires about two weeks to hatch, and the bug becomes full grown and acquires its wings in from 40 to 50 days after hatching.

[Fig. 2.]

There are, as is well known to Entomologists, many genera of the Half-winged Bugs, which in Europe occur in two distinct or "dimorphous" forms, with no intermediate grades between the two; namely, a short-winged or sometimes even a completely wingless type and a long-winged type. Frequently the two occur promiscuously together, and are found promiscuously copulating so that they cannot possibly be distinct species. Sometimes the long-winged type occurs in particular seasons and especially in very hot seasons. More rarely the short-winged type occurs in a different locality from the long-winged type, and usually in that case in a more northerly locality. We have a good illustration of this latter peculiarity in the case of the Chinch Bug, for a dimorphous short-winged form (Fig. 2.) occurs in Canada, and Dr. Fitch describes it from specimens received from the States, as a variety, under the name of *apterus*.

DESTRUCTIVE POWERS OF THE CHINCH BUG.

Few persons in the more Northern States can form a just conception of the prodigious numbers and redoubtable armies in which this insect is sometimes seen in the South and Southwestern States,

*In Dr. Shimer's Paper the dimensions of the egg, as "determined with fine mathematical instruments," are said to be "0.04 inch long and 0.01 inch wide," (p. 99.) This is either a clerical or a typographical error for "0.004 inch long and 0.001 inch wide." Otherwise the egg would be nearly one-third as long as the insect itself; and as Dr. Shimer thinks that every female lays about 500 eggs, this would be something like getting a bushel of wheat out of a quart measure.

marching from one field to another. The following extracts—the first one written in June, 1865, by Dan. F. Rogers to the New York Farmers' Club, and the second from an old number of the *Prairie Farmer*—may seem a little far-fetched, but I have no doubt that both accounts are substantially correct:

There never was a better "show" for wheat and barley than we had here the 10th of June, and no more paltry crop has been harvested since we were a town. Many farmers did not get their seed. In passing by a field of barley where the Chinch Bugs had been at work for a week, I found them moving in solid column across the road to a corn field on the opposite side, in such numbers that I felt almost afraid to ride my horse among them. The road and fences were alive with them. Some teams were at work mending the road at this spot, and the bugs covered men, horses and scrapers till they were forced to quit work for the day. The bugs took ten acres of that corn, clean to the ground, before its hardening stalks—being too much for their tools—checked their progress. Another lot of them came from a wheat field adjoining my farm into a piece of corn, stopping now and then for a bite, but not long. Then they crossed a meadow 30 rods into a 16 acre lot of sorgo, and swept it like a fire, though the cane was then scarce in tassel. From wheat to sorgo was at least sixty rods. Their march was governed by no discoverable law, except that they were infernally hungry, and went where there was most to eat. *Helping a neighbor harvest* one of the few fortunate fields, early sown—and so lucky!—we found them moving across his premises in such numbers that they bid fair to drive out the family. House, crib, stable, well-curb, trees, garden fences—one *creeping* mass of stinking life. In the house as well as outside, like the lice of Egypt, they were everywhere; but in a single day they were gone.

If any Western rustics are verdant enough to suppose that Chinch Bugs cannot be out-flanked, headed off and conquered, they are entirely behind the times. The thing has been effectually done during the past season, by Mr. Davis, Supervisor of the town of Scott, Ogle county, Ill. This gentleman had a cornfield of a hundred acres, growing alongside of an extensive field of small grain. The bugs had finished up the latter and were preparing to attack the former, when the owner, being of an ingenious turn, hit upon a happy plan for circumventing them. He surrounding the corn with a barrier of pine boards set up edgewise, and partly buried in the ground, to keep them in position. Outside of this fence deep holes were dug, about ten feet apart. The upper edge of the board was kept constantly moist with a coat of coal tar, which was renewed every day.

The bugs, according to their regular tactics, advanced to the assault in solid columns, swarming by millions, and hiding the ground. They easily ascended the boards, but were unable to cross the belt of the coal tar. Sometimes they crowded upon one another so as to bridge over the barrier, but such places were immediately covered with a new coating. The invaders were in a worse quandary than that of Butler and Weitzel at Fort Fisher, and, in that state of mind crept backward and forward until they tumbled into the deep hole aforesaid. These were soon filled, and the swarming myriads were shoveled out of them literally by wagon loads, at the rate of thirty or forty bushels a day—and buried up in other holes, dug for the purpose, as required. This may seem incredible to persons unacquainted with this little pest, but no one who has seen the countless myriads which cover the earth as harvest approaches, will feel inclined to dispute the statement. It is an unimpeachable fact. The process was repeated till only three or four bushels could be shovelled out of the holes, when it was abandoned. The corn was completely protected, and yielded bountifully.

HEAVY RAINS DESTRUCTIVE TO THE CHINCH BUG.

As the Chinch Bug, unlike most other true Bugs, deposits its eggs underground, and as the young larvæ live there for a considerable time, it must be manifest that heavy soaking rains will have a tendency to drown them out. The simple fact, long ago observed and recorded by practical men, such as Mr. B. E. Fleharty of North Prairie, Knox county, Ills., that this insect scrupulously avoids wet land, proves that moisture is naturally injurious to its constitution. Hence it was many years ago remarked by intelligent farmers, and we had an illustration of it the present year (1869), that very often when the spring opens dry, Chinch Bugs will begin to increase and multiply in an alarming manner; but that the very first heavy shower checks them up immediately, and repeated heavy rains put an almost entire stop to their operations. It is very true that nearly all insects will bear immersion under water for many hours, and frequently for a whole day, without suffering death therefrom; for although animation is apparently suspended in such cases, they yet, as the phase is, "come to life again." But no insect, except the few that are provided with gills like fishes and extract the air out of the water, instead of breathing it at first hand, can stand a prolonged immersion in water without drowning. And it must be obvious to the meanest capacity, that an insect, such as the Chinch Bug, whose natural home is the driest soil it can find, will have its health injuriously affected by a prolonged residence in a wet soil.

In fact the whole history of the Chinch Bug, from the very earliest records which we have of it, points unmistakably to the fact that a wet season affects it injuriously, and often almost annihilates it. arolina and Virginia, during the dry years which preceded 1840, it had become so numerous that the total destruction of the crops was threatened; but fortunately, unlike its predecessors, the summer 1840 was quite wet and the ravages of the bug were at once arrested. In Illinois and in this State it had increased to an alarming extent during the latter part of the late Rebellion; but the excessive wet summer of 1865 swept them away to such an extent that it was difficult to find any in the fall of that year. So it was again in 1869–70, and so it always has been, and doubtless always will be. It will be well therefore for farmers to bear in mind, that *in a hot, dry season Chinch Bugs are always the worst, and that in a wet season it is impossible for them to do any considerable amount of damage.*

Dr. Shimer, however, is not satisfied with this simple theory. He has gotten up and expounded to the world a new and recondite theory of his own, namely, that in the terrible wet season of 1865, when the Chinch Bug, although in early spring it had appeared in very great numbers, was almost annihilated in the course of the summer, it perished, not as others had foolishly supposed, from the direct operation of the rain, but indirectly through a certain mysterious epidemic disease analogous to the Cholera or the Yellow Fever among human beings. He fully allows that the mortality among the Chinch Bugs was contemporaneous with the wet weather; but he will have it that it was not the wet weather that killed the Bug, as we common folks have always hitherto believed, but that it was his newly-discovered Epidemic Disease. But as in the conjoint article in the *American Entomologist* (I, pp. 174–6) this Epidemic theory was fully considered by my late associate, Mr. Walsh, in his own peculiar style, I shall not dwell upon it here.

CANNIBAL FOES OF THE CHINCH BUG.

As long ago as 1861, Mr. Walsh, in his *Essay upon the Injurious Insects of Illinois*, published facts which tended to show that four distinct species of Ladybirds preyed upon the Chinch Bug.* The first of these four is the Spotted Ladybird (*Hippodamia maculata*, DeGeer, Fig. 3), which also preys upon a great variety of other insects, attacking both the eggs of the Colorado Potato Bug and those of certain Bark-lice; and which is further remarkable for being one of the few insects found both in Europe and in North America.

[Fig. 3.]

[Fig. 4.]

In corroboration of the fact of its preying on the Chinch Bug, I may state, that the Rev. Chas. Peabody, of Sulphur Springs, informs me that he has repeatedly found it so feeding on his farm. The second species is the Trim Ladybird (*Coccinella munda*, Say, Fig. 4), which is distinguishable at once from a great variety of its brethren by having no black spots upon its red wing-cases. The other two are much smaller insects, belonging to a genus (*Scymnus*) of Ladybirds, most of the species of which are quite small and of obscure brown colors, and hard to be distinguished by the popular eye from other beetles, the structure of which is very different, and which therefore belong to very different groups and have very different habits.

In the autumn of 1864 Dr. Shimer ascertained that the Spotted Ladybird which has been sketched above, preys extensively upon the Chinch Bug. In a particular field of corn, which had been sown thick for fodder, and which was swarming with Chinch Bugs, he found, as he says, that this Ladybird, "could be counted by hundreds upon every square yard of ground after shaking the corn; but the Chinch Bugs were so numerous that these hosts of enemies made very little perceptible impression among them."

In the same autumn Dr. Shimer made the additional discovery, that in the very same field of fodder-corn the Chinch Bugs were preyed upon by a very common species of Lacewing-fly, which he

*See *Trans. Ill. St. Agric. Society*, IV, pp. 346–9.

described in January, 1865,* as the Illinois Lacewing (*Chrysopa Illinoiensis*). The description was republished, together with the substance of Mr. Shimer's observations in the *Prairie Farmer*, of Chicago, Ill., accompanied with a non-characteristic wood-cut of the larva, cocoon and imago. At this time Mr. Shimer favored me with two specimens of the perfect insect, and he likewise furnished Mr. Walsh with additional specimens. From these specimens, it is evident that the species is the same as that described long before, by Dr. Fitch, as the Weeping Lacewing (*Chrysopa plorabunda*). In 1868, I found the same species quite numerous in a wheat field belonging to Mr. T. R. Allen, of Allenton, where its larvæ were perhaps feeding on the Chinch Bugs, as they were found to do in North Illinois, by Dr. Shimer.

[Fig. 5.]

The Lacewing flies all bear a striking resemblance to one another, both in size, shape and color; and to convey a correct idea of their appearance, it is only necessary to repeat the annexed drawing (Fig 5.) from my First Report, where a sketch of their natural history will be found (pp. 57–8).† They almost all of them, in the fly state, have a characteristic and disagreeable odor, resembling nothing so much as human ordure.

According to Dr. Shimer, the Weeping Lacewing-fly was not quite as abundant as the Spotted Ladybird among the fodder-corn, but still there were so many of them, that he thought that "there was one or more of them for every stalk of that thickly sown corn." "Every stroke of the cutter," he adds, "would raise three or four dozen of them, presenting quite an interesting spectacle as they staggered along in their awkward, unsteady flight." And he not only actually observed the larvæ preying very voraciously on the Chinch Bugs in the field, but he reared great numbers of them to the mature Fly by feeding them upon Chinch Bugs. His account of the operations of the larva when in captivity is so interesting that I quote it in full:

I placed one of the larvæ in a vial, after having captured it in the field in the very act of devouring Chinch Bugs of all sizes, and subsequently introduced into the vial a number of Chinch Bugs. They had hardly reached the bottom before it seized one of the largest ones, pierced it with its long jaws, held it almost motionless for about a minute while it was sucking the juices from the body of its victim, and then threw down the lifeless shell. In this way, I saw it destroy in quick succession, about a dozen bugs. Towards the last, as its appetite was becoming satiated, it spent five or more minutes in sucking the juices from the body of one bug. After this bountiful repast, it remained motionless for an hour or more, as if asleep. Never for

*Proc. Ent. Soc. Phil., IV, pp. 208–12.

†In that account I stated as a fact which, so far as I was aware, had not been recorded by any previous writer, that the insect issues from the small cocoon in an active sub-imago state, from which, after a few hours, the winged fly emerges, leaving behind it a fine silvery-white transparent skin. I have since found that Dr. Shimer, in the scientific paper already referred to, had previously recorded the very same fact.

a single moment, during the feast, did it pause in the work. When not in possession of a bug, it was on the search for, or in the pursuit of others. It manifested much eagerness in the pursuit of its prey, yet not with a lion-like boldness; for on several occasions I observed a manifest timorousness, a halting in the attack, as if conscious of danger in its hunting expeditions, although here there was none. Sometimes, when two or more bugs were approaching rapidly, it would shrink back from the attack, and turning aside go in the pursuit of others. At length, awakening, it would renew the assault as before. On one occasion, when it was on the side of the vial, two inches up, with a large bug in its mouth, I jarred the vial, so that it fell to the bottom and rolled over and over across the bottom, but holding on to its prey, it regained its footing and mounted up to its former position. Occasionally the Chinch Bugs would hasten to escape when pursued, as if in some degree conscious of danger.

Fig. 6.

I

The Insidious Flower Bug, (*Anthocoris insidiosus*, Say), of which I represent herewith a highly magnified figure, (Fig. 6), may often be found in company with the Chinch Bug, under the husks of ears of corn. It is quite common in Missouri, where I have found it in several different galls, and especially in the Grape-vine Leaf-gall, where it was preying on the lice (*Phylloxera vitifoliæ*), which are the architects of the gall. It has often been mistaken for the Chinch Bug, and was upon one occasion sent to Dr. Fitch, by one of his correspondents, for that veritable Bug. Yet it undoubtedly preys upon the Chinch Bug, as well as upon a variety of other plant-feeding insects, and it therefore becomes very necessary that the farmer should learn to recognize it and distinguish it from the true culprit. It is very true that, practically, it will be found almost impossible to separate the sheep from the goats, and spare the lives of the former while condemning to destruction the unsavory little carcasses of the latter. Still, it will be some comfort to the grain-grower, when at some future day he may discover his small grain or his corn to be alive with Chinch Bugs, to perceive the bright orange-colored larvæ of the Insidious Flower-Bug dodging about among the blood-red or blood-brown larvæ of his bitter foes, and sucking out their life-blood with ravenous avidity; or to discover the little slow-going larvæ of the *Scymnus* group of Ladybirds, with such dense and evenly-shorn masses of short milk-white cottony threads growing out of their entire bodies that they look like little animated flakes of cotton wool, crawling about among the stinking crowd and making many a hearty meal off them, stink they never so badly; or, finally, to watch the lizard-like black and yellow larvæ of the Spotted Ladybird, and the Trim Ladybird, with their short, robust jaws, or the greenish-brown larvæ of the Lacewing-fly, with their long slender sickle-shaped jaws, running rapidly about among the hosts of their enemies, and smiting them hip and thigh without any more mercy than the Amalekites of old experienced at the hands of avenging Israel. He will then know that, even if he is himself powerless to make head against a host of minute foes, as numerous as the sand on the seashore, and as destructive and irresistible as the waves of the great ocean itself, Providence has provided a check upon the unlimited increase of his enemies; and that a Power which is above us all and provides for us all, and which alloweth not even a sparrow to fall to the ground unless by His especial permission, has said to every vegetable-feeding insect, through the mouths of the various Cannibal and Parasitic species which He has appointed to do His work: "Thus far shalt thou go, and no farther; and here shall thy proud hosts be stayed."

The common Quail of the Middle and Western States (*Ortyx Virginiana*) otherwise known as the Partridge in the Northern States has long since been known as a most efficient destroyer of Chinch Bugs, and the fact was some time ago published by myself in the *Prairie Farmer*, and by others in various Agricultural Journals and Reports. We also have the corroborative testimony of Dr Shimer, who is a good ornithologist. In the winter time, when hard pushed for food, this bird must devour immense numbers of the little pests which winter in just such situations as are frequented by the Quail; and this bird should be protected from the gun of the sportsman in every State where the Chinch Bug is known to run riot.

AMOUNT OF DAMAGE DONE BY THE CHINCH BUG.

According to Dr. Shimer's estimate, which may be considered a reasonable one, in the year 1864 "three-fourths of the wheat and one-half of the corn crop were destroyed by the Chinch Bug throughout many extensive districts, comprising almost the entire Northwest." At the average annual rate of increase, according to the United States Census, in the State of Illinois, the wheat crop of 1864 ought to have been about thirty millions of bushels, and the corn-crop about one hundred and thirty-eight million bushels. Putting the cash value of wheat at $1.25 and that of corn at 50 cents, the cash value of the corn and wheat destroyed by this insignificant little bug, no bigger than a grain of rice, in one single State and in one single year, will therefore, according to the above figures, foot up to the astounding total of OVER SEVENTY-THREE MILLIONS OF DOLLARS! Put it as low as we choose, it is still a "big thing;" and it is unnecessary to argue a question any further, when facts and figures speak so plainly.

REMEDIES AGAINST THE CHINCH BUG.

It has long been noticed that the Chinch Bug commences its ravages in the spring from the edges of a piece of grain, or occasionally from one or more small patches, scattered at random in the more central portions of it, and usually drier than the rest of the field. From these particular parts it subsequently spreads by degrees over the whole field, multiplying as it goes and finally taking the entire crop unless checked up by seasonable rains. In newly-broken land, where the fences are new and consequently no old stuff has had time to accumulate along them, the Chinch Bug is never heard of. These facts indicate that the mother insects must very generally pass the winter in the old dead stuff that usually gathers along fences. Hence, by way of precaution, it is advisable, whenever possible, to burn up such dead stuff in the winter or early in the spring, and particularly to rake together and burn up the old corn-stalks, instead of plowing them in, or allowing them, as is often done, to lie littering about on some piece of waste ground. It is true, agriculturally speaking, this is bad farming; but it is better to lose the manure contained in the corn-stalks than to have one's crop destroyed by insects. Whenever such small infected patches in a grain field are noticed early in the season, the rest of the field may often be saved by carting dry straw on to them and burning the straw on the spot, Chinch Bugs, green wheat and all; and this will be still easier to do when the bugs start along the edge of the field. If, as frequently happens, a piece of small grain is found about harvest-time to be so badly shrunken up by the bug as not to be worth cutting, the owner of it ought always to set fire to it and burn it up along with its ill-savored inhabitants. Thus, not only will the insect be prevented from migrating on to the adjacent corn-fields, but its future multiplication will be considerably checked.

A very simple, cheap and easy method of prevention was recommended in the *Prairie Farmer* of April 19th, 1862, by Mr. Wilson Phelps, of Crete, Illinois. It may very probably be effectual when the bugs are not too numerous, and certainly can do no harm:

With twelve bushels of spring wheat mix one bushel of winter rye, and sow in the usual manner. The rye not heading out, but spreading out close to the ground, the bugs will content themselves with eating it, until the wheat is too far advanced to be injured by them. There will, of course, be no danger of the winter rye mixing with the spring wheat.

When Chinch Bugs are likely to march, as they often do, after the fashion of Army-worms, from an infected to an uninfected field, Mr. H. J. Everest, of Stoughton, Dane county, Wisconsin, recommends the following plan, which is stated to have been tried by several persons and found to be perfectly effectual, and which is substantially the same as that referred to on page 23:

Take common fence-boards, six inches or less wide, and run them around the piece, set edgewise, and so that the bugs cannot get under them or between the joints, and then spread either pine or coal tar on the upper edge, and they will not cross it. The tar needs renewing till the edge gets saturated, so that it will keep wet and not dry in any more, and either kind of tar is effectual. Then dig holes close to the boards, about like a post-hole, once in four or five rods, and run a strip of tar from the top of the board to the bottom on the outside opposite the hole, and they will leave the board, and in trying to get around the tarred stripe will slide into the hole, where they will be obliged to remain till they can be buried at leisure, and new holes opened for more victims. It is seldom one has to fence more than one side of a field, but wherever the fence is, it is a sure stop.—*Proc. New York Farmers' Club.*

Finally, when the Chinch Bugs are already in the field which it is proposed to rescue from their clutches, Mr. Michael Hopps, of Lyonsville, Cook county, Illinois, says that he saved a piece of wheat by sowing gas-lime broadcast over it, at the rate of six or seven bushels to the acre; and that the effect was that the bugs immediately left his field, and his crop was saved, while the wheat of his neighbors was nearly ruined by them. He further states that "a neighbor had a field of wheat adjoining his (Mr. Hopps's) cornfield, in which the bugs worked badly. Thinking that, as soon as the wheat was cut, they would emigrate to his corn, he dropped a handful of the gas-lime upon each hill of corn, in the same manner as plaster is often dropped upon corn in the East. The consequence was that the bugs did not attack the corn in the least."—(*Prairie Farmer.*)

But, if gas lime keeps off Chinch Bugs, which may or may not be the case, it appears that coal-tar most certainly will not do so, as the following experiment of Dr. Shimer's proves:

May 26th, 1864.—I saturated some saw-dust with coal-tar, and mixed some quick-lime among it, so that it might be in a good condition for handling, and sowed it thickly broadcast over a portion of my wheat field, where the bugs were very numerous.

May 27th–29th, 1864.—The bugs refuse to leave the part of the field where I sowed the tarred saw-dust, so there is but little hope of driving them from their once chosen grounds, by the seasonable application of strong smelling drugs.

I have known farmers to follow the plan of going through a wheat field badly infested with Chinch Bugs, and with a sickle to cut, here and there, small patches of the wheat which they threw on the ground in the form of a loose irregular shock. The bugs would gather under these cut stalks in great numbers from the standing grain, and could then be destroyed either by crushing or by burning them with straw.

The above remedies are selected as the most likely to prove practically successful, from a mass floating round in the various Agricultural Journals, some of them utterly absurd and irrational, and others of very doubtful use. As to the ridiculous proposal put forth in the Waukegan (Ills.) *Gazette*, in 1865, with a great flourish of trumpets, by one D. H. Sherman of that town; namely, to destroy the Chinch Bugs in the egg state by pickling all the seed wheat; it is sufficient to observe that this insect *never* deposits its eggs upon the kernel of the ripe wheat. Consequently, to attempt to kill Chinch Bug eggs, by doctoring the seed wheat, would be pretty much like trying to kill the nits in a boy's head by applying a piece of sticking-plaster to his great toe. In the old *Practical Entomologist* (I, p. 48), I showed that there were no such eggs in the wheat kernels, which Mr. Sherman himself had sent me, and which he had supposed to be thus infested.

BOGUS CHINCH BUGS.

Few things are more astonishing than the acuteness of perception superinduced by being constantly conversant with some one particular subject. I have often been surprised at the readiness with which nurserymen will distinguish between different varieties of Apple, even in the dead of the year, when there are no leaves, and of course no fruit on their nursery trees. In the same way old practiced shepherds can recognize every individual sheep out of a large flock, though, to the eyes of a common observer, all the sheep look alike. Experienced grain-growers, again, can distinguish at a glance between twenty different varieties of wheat, which the best botanist in the country would fail to tell one from the other; and I have been informed that a miller of many years' standing, as soon as he has shouldered a sack of wheat, knows at once whether it is spring grain or fall grain; while ninety-nine entomologists out of every hundred would probably be unable, on the most careful inspection, to tell the difference between the two, and some might even mistake wheat for rye.

It is not surprising, therefore, that persons who have paid no particular attention to the study of insects, often confound together insects which, in the eyes of the professed entomologist, look as different from each other as a horse does from a cow or a hog. It would, indeed, be little short of miraculous if this were not so; for there are about thirty thousand distinct species of insects to be found within the limits of the United States, and of course in such a vast multiplicity, there must be many strong resemblances.

I will therefore conclude this article on the Chinch Bug, by briefly mentioning several true Bugs, belonging to the same Order of Half-winged Bugs (*Heteroptera*), as that pestilent little foe of the farmer, and which I know to be frequently mistaken for it. The reader will then, by comparing the different figures, see at once how widely they all differ, and by a very little practice, his eyes will become so well educated that he will soon, without any artificial assistance from glasses, be able to distinguish the creatures one from the other, as they crawl or fly about in the almost microscopic dimensions assigned to them by their Great Creator.

One reason, perhaps, why so many different bugs are popularly confounded with the Chinch Bug, is the similarity of their smell. Everybody is aware that Chinch Bugs possess the same peculiarly unsavory odor as the common Bed Bug; and hence when a person finds a small insect that has this obnoxious smell, he is very apt to jump to the conclusion that it must be a Chinch Bug. No mode of reasoning, however, can be more unsafe or unsound. There are hundreds of different species of Half-winged Bugs—the common brown Squash Bug (*Coreus tristis*) for example—that possess this peculiar smell; and what is stranger still, although this smell is more usually met with among the plant-feeders, there are a few of the true Cannibals that possess it to perfection. Among these I may mention the Spined Soldier-bug (*Arma spinosa*, Dallas) whose portrait I here re-

[Fig. 7.]

a b

produce from my First Report (Fig. 7 *b*); for, as the bitterest enemy of the Colorado Potato Bug, and consequently one of our best friends, he cannot too often be presented, or become too well known. We can well afford to endure his unpleasant odor, when we duly reflect on his kind services. Just think of it, you bitter bug-haters—this little soldier has, beyond all doubt, saved thousands of dollars to the State of Missouri in the last few years, by heroically stabbing and slaying countless hosts of one of your worst enemies! That he should have the bed-buggy odor is not very surprising, since he appertains to a large and extensive group, (the *Scutellera* family) most of the other species belonging to which are plant-feeders. Indeed it is a very general rule, to which I know of but one exception* that the insect in the great *Reduvius* family among the Half-winged Bugs, every one of which is of carnivorous propensities, never have this peculiarly nauseous aroma; and that it is bestowed only upon certain plant-feeding bugs, to protect them no doubt from their insect foes, in the same manner as the skunk is protected from the eagle by his odoriferous tail. Yet while many of the plant-feeding Bugs do have this odor, a good many of them are entirely free from it, and some few of them really smell so agreeably that the fact has been thought worthy to be recorded by entomological writers. Even that detestable pest, already referred to, the common Squash Bug, sometimes emits a pleasant aroma, altogether different from that which it normally gives out; for I have kept this winter, in a separate box, one which emits a most pungent but agreeable smell, very much resembling that of a very ripe, rich pear. But perhaps the most suggestive fact of all is that, notwithstanding the close alliance between the two Orders of Half-winged and Whole-winged Bugs, there is not a single known species of the latter that has ever been known to exhale the bedbuggy effluvium, which is met with in so many species belonging to the former.

THE INSIDIOUS FLOWER-BUG.—First among the insects frequently mistaken for the Chinch Bug, may be mentioned the Insidious Flower-bug (*Anthocoris insidiosus*, Say) already referred to under the head of "Cannibal Foes of the Chinch Bug." This little Flower-bug has been usually referred by entomologists to the same extensive group (*Lygæus* family) as the true Chinch Bug, though more recent authors have placed it in a distinct group on account of its short three-jointed beak.

THE ASH-GRAY LEAF-BUG.—Second among the Bogus Chinch Bugs may be mentioned the Ash-gray Leaf-bug (*Piesma cinerea*, Say) a

* A shiny black species of *Nabis* (*Nabis marginatus*, Uhler, MS) smells as much like a Bed Bug as the most peaceable Plant-feeder.

small greenish-gray bug of which I present herewith a highly magnified figure (Fig. 8), its true size being about the same as that of the Chinch Bug for which it has been mistaken, though it lacks altogether the conspicuous black and white markings which characterize that

[Fig. 8.]

little grain pest, and really resembles it in nothing but the unpleasant odor which it emits. In the summer of 1868, Col. F. Hecker, of St. Clair county, Illinois (See *Am. Entomologist*, I, p. 19), found an insect, which he mistook for the Chinch Bug, destroying the blossom buds of his grape-vines. Now as the Ash-gray Leaf-bug is known to work in this way on the Grape-vine, and as I found it abundant in Col. Foster's vineyard, on the Iron Mountain Railroad in this State, it was doubtless this species which injured Col. Hecker's vines; for the true Chinch Bug has never hitherto been observed to attack woody plants like the Grape-vine, but confines itself exclusively to herbaceous plants, such as wheat, oats, Indian corn, etc. The Ash-gray Leaf-bug belongs to an entirely different group from the Chinch Bug (*Tingis* family) all the species of which have a short 3-jointed beak, which however differs from that of the 3-jointed beak of the Flower-bugs (*Anthocoris*) by being encased in a groove when not in use. They mostly live on green leaves in all their three stages, after the fashion of plant lice. Like the Chinch Bug, the Ash-gray Leaf-bug hybernates in the perfect state, and may be found in the winter in considerable numbers under the loose bark of standing trees and especially under that of the Shag-bark Hickory.

With the exception of the Ash-gray Leaf-bug, there is no North American species belonging to the genus, that is known to attack fruit trees or fruit-bearing bushes or vines; though there are several that infest forest trees—each species generally confining itself to a particular genus of trees. But in Europe there is a species, the Pear-tree Leaf-bug (*Tingis pyri*) which is so injurious to the Pear, that the French gardeners have given it the name of "the Tiger." It is to be hoped that it may never, like another European pest of pear-growers, the Pear-tree Flea-louse (*Psylla pyri*)—which has already been introduced into the New England States, and will perhaps make its way out West—traverse the Atlantic ocean and take out its naturalization papers in this country.

THE FLEA-LIKE NEGRO-BUG.—Third among the bogus Chinch Bugs may be mentioned the Flea-like Negro-bug (*Corimelæna pulicaria*,

[Fig. 9.]

Germar), of which I here present a magnified outline (Fig. 9). Its color is black with a white stripe each side. This insect resembles the Chinch Bug in having an ordinary 4-jointed beak, but differs from it in belonging to a very distinct and well marked group (*Scutellera* family), which is characterized by the enormous size of the "scutel" or shield.

In the most numerously represented division of this family the scutel forms a large triangle, extending along the back about half-way to the tip of the abdomen, as may be seen in the figure of the Spined Soldier-bug (Fig. 7), referred to on a previous page. But in another division of this family which does not contain nearly so many species, the scutel, instead of being angular, is rounded at top and covers more or less the entire upper surface of the abdomen. It is to this last division that the Flea-like Negro-bug belongs, and the dirty yellow or white stripes at its sides are really nothing but the thickened anterior edge of the front wings, all the remaining part of the front wings, as well as the entire hind wings, being, in repose, completely hidden under this enormously extended shield. In the Bordered Soldier-bug, as the reader will perceive from the annexed drawing (Fig. 10), which I reproduce from my First Report, the scutel is indeed rounded, and also extends a considerable distance over the abdomen; but as it otherwise agrees with the other Soldier-bugs in the rest of its organization, it is classified with them, and not with our Negro-bug.

[Fig. 10.]

The Flea-like Negro-bug has been known to injure various plants for two or three years back. I found it exceedingly abundant last summer in all parts of the State which I visited. It has a great passion for the fruit of the Raspberry, and is sometimes so plentiful as to render the berries perfectly unsaleable by the bed-bug aroma which it communicates to them, as well as by sucking out their juices. Wherever it occurs, the nauseous flavor which it imparts to every berry which it touches, will soon make its presence manifest, though the little scamp may elude ocular detection. It is really too bad that such a little black varmint should so mar the exceeding pleasure which a lover of this delicious fruit always experiences when in the midst of a raspberry plantation in the fruit season. It is also quite injurious to the Strawberry, puncturing the stem with its little beak, and thus causing either blossom or fruit to wilt; and the following extract, taken from a communication to the *Western Rural* by Mr. B. Pullen, of Centralia, Ills., undoubtedly refers to the same Bug, and would indicate that it made its first appearance in that neighborhood last summer:

"A new insect, to us here, has appeared on our strawberries for the first time the past season, damaging the crop very much. It resembles somewhat the Chinch Bug, so destructive to our wheat and corn, and, judging from the peculiar odor they emit on being mashed, should think them very nearly related. Some claim that they are of a different species altogether. Whether this be so or not those interested in the cultivation of the strawberry are anxiously looking forward to another season to see if they are to continue their depredations."

It likewise attacks the Strawberry in Canada, as an account of its attacking that plant, is given by my friend, C. J. S. Bethune, in the

Canada Farmer for August 1st, 1867; and it was under this very same serious charge that it was apprehended and brought up for trial at the last May meeting of the Alton (Ills.) Horticultural Society. It also attacks both Cherry and Quince, occurring on these trees in very large numbers, and puncturing the blossoms and leaves, but especially the fruit stems, which in consequence shrivel and die. It is also quite injurious to garden flowers and especially to the Coreopsis, and abounds on certain weeds, among which may be mentioned the Red-root or New Jersey Tea-plant (*Ceanothus Americanus*), and Neckweed or Purslane-speedwell (*Veronica peregrina*). In the month of June under these two last named plants, they may be found in countless numbers of all sizes and ages, from the small light brown wingless, newly hatched individuals, to the full fledged jet black ones. In fact they breed on these weeds, and there is no more effectual method of checking their increase and thus preventing their injuries to our cultivated fruits, than by sprinkling these weeds, and the ground underneath them, with a good strong solution of Cresylic soap. I should advise the propagation of a small patch of either one of these weeds near a strawberry patch, as a decoy for the Bugs, which may thus be, to some extent, enticed away from the strawberry plants, and killed more readily.

There are two other species of Negro-bug which are common in this State, though they never swarm in such injurious profusion as does the Flea-like Negro-bug. The first of these (*Corimelæna lateralis*, Fabr.) is absolutely undistinguishable from it however, except in being fully one-half longer and wider. The shape, sculpturing and coloring are exactly the same, even down to the lateral white stripe; so that, but for the fact of no intermediate grades in size occurring, the two would be certainly considered as mere varieties of one and the same species. The other Negro-bug (*Cor. unicolor*, Beauv.) is fully twice as long and wide as our insect; but though resembling it closely in every other respect, yet differs very notably in lacking the white anterior edging to the front wings. It might indeed be said, that the biggest Negro dresses entirely in black, while the two other smaller sized darkies relieve the sombre monotony of their sable suits, by wearing a conspicuously white shirt-collar.

To these three bogus Chinch Bugs, might be added one or two other species of small stinking Bugs which have been, by some persons, mistaken for the true Chinch Bug. But enough has been already said to show, that insects which in reality are shaped and fashioned as differently as are cows and deer, are yet often confounded together in the popular eye, principally, no doubt, because they have the same peculiar bed-bug aroma. Should the ignorance of the popular judgment in confounding these tiny creatures which seem to the Entomologist so very, very different from each other, therefore, be despised and ridiculed? Far be it from me to display such intolerant stupidity! As well might the nurseryman ridicule the grain grower, because the grain-grower cannot distinguish a Baldwin Seedling from a High top apple; or the grain-grower the nurseryman because the nurseryman cannot tell Mediterranean from Tea wheat, or Club from Fife. I do, however, entertain an abiding hope that by the present very general and praiseworthy movement towards the popularization of Natural History, and by the dissemination of Entomological Reports, a better knowledge of this practically important subject will soon exist in the community. Our farmers will then, not so often wage a war of extermination against their best friends, the cannibal and parasitic insects, while they overlook and neglect the very plant-feeders which are doing all the damage, and upon which the others are feeding in the very manner in which a Wise Providence has appointed them to adopt.

RECAPITULATION.

The following important points in the history of the Chinch Bug, may be considered as firmly established:

1st. Chinch Bugs hybernate in the perfect or winged state in any old dry rubbish, under dead leaves, in old straw, in corn-shucks and corn-stalks, among weeds in fence-corners, etc., etc. Therefore all such substances should be burned up, as far as possible, in the spring.

2nd. The earlier small grain can be sowed in the spring, the more likely it is to escape the Chinch Bug; for it will then get ripe before the spring brood of bugs has had time to become fully developed at the expense of the grain.

3d. The harder the ground is where the grain is sowed, the less chance there is for the Chinch Bug to penetrate to the roots of the grain and lay its eggs thereon. Hence the importance of fall-ploughing and using the roller upon land that is loose and friable. And hence, if old corn-ground is sufficiently clean, it is a good plan to harrow in a crop of small grain upon it without ploughing it at all. Moreover this rolling plan should always be adopted, as the best wheat-growers both in this country and in Europe attest that the heavier the ground for wheat is rolled, the better will be the crop.

4th. A single heavy rain immediately checks up the propagation of the Chinch Bugs. Continued heavy rains diminish their numbers most materially. A long-continued wet season, such as that of 1865, almost sweeps the whole brood of them from off the face of the earth; but from the rapid rate at which they multiply there will always be enough left for seed for another year. It may be laid down, not only as a general, but universal rule, that this insect is never ruinously destructive, except in those sections of country where there is continued hot dry weather; and that if, in two adjoining districts, there has been a dry summer in one and much wet weather during the summer season in the other, however plentiful and destructive the bug may be in the first district, it will scarcely be heard of in the second. Certainly this state of facts is not exactly that from which any reasonable man would infer, that the paucity of Chinch Bugs in a wet season is caused by an Epidemic Disease taking them off. We might as well maintain that, although there was no Epidemic Disease among the children of Israel that had just crossed the Red Sea, or among the Egyptians that staid at home, it was simply and solely an Epidemic Disease that slew the pursuing hosts of the Egyptians and covered the bottom of the Red Sea with their carcasses.

THE ARMY-WORM—*Leucania unipuncta*, Haw.

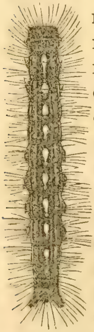
[Lepidoptera Noctuidæ.]

Among those insects which attract especial attention, either from the peculiarity of their habits, or the vast amount of damage which they inflict, the notorious Army-worm holds a conspicuous place. The mode in which these worms travel in vast armies when in search of food, the great value of the cereals and the grasses to which they for the most part confine their ravages, their sudden appearance in such incomputable numbers, and their equally sudden disappearance, all tend to arouse the curiosity and interest of even the most indifferent observer.

Before giving a history of this insect, it will be necessary to state that there are four distinct caterpillars, producing four perfectly distinct moths, which have been designated as Army-worms in various parts of the United States.

First—The Tent-caterpillar of the Forest (*Clisiocampa sylvatica*, Harr.) has been erroneously known by the name of "Army-worm" in the northwest corner of the State of New York. A back view of this caterpillar is given in the accompanying sketch (Fig. 11) by which it will at once be recognized by the reader. For a number of days, last June, this worm might have been seen marching "single file" up the railroad track on Pilot Knob, in the scorching rays of the noonday sun; and it is often found crawling along roads in very considerable numbers. Yet it cannot with propriety be called an Army-worm, and our Eastern friends had best drop the title and avoid confusion in the future.

[Fig. 11.]



Second—The Cotton-worm (*Anomis xylina*, Say), is very generally known by the name of "the Cotton Army-worm," in the South. The term as applied to this species is not altogether inappropriate, as the worm frequently appears in immense armies, and when moved by necessity will travel over the ground in "solid phalanx;" and so long as the word "Cotton" is attached—its ravages being strictly confined to this plant—there is no danger of its being confounded with the true Army-worm. The term has furthermore received the sanction of custom in the Southern States, and of Mr. Glover in his Department Reports.

As various attempts have been made, with more or less success, to grow the cotton plant in the southern parts of this State, a description of this insect will not be inappropriate, the more especially, since it will teach the reader the difference between it and the true Army-worm.

The Cotton-worm was first scientifically described by Mr. Thomas Say, in the year 1827. According to Dr. D. L. Phares, of Woodville, Miss., it destroyed at a low estimate, 200 tons of cotton in the Bahamas as long ago as 1788; while in Georgia it completely destroyed the crop in 1793. According to Dr. Capers* its injuries were noticed in 1800, and it likewise proved very destructive in 1804, 1825 and 1826. Since the last date, as we may learn from old volumes of the *American Farmer*, of Baltimore, Md., and from the Patent Office Reports, it has done more or less damage to the crop almost annually, in some part or other of the cotton-growing district. As with the real grass-feeding Army-worm of the Middle States, it swarms in particular years to such an extent as to utterly ruin the crop, while in other years it is scarcely noticed. This fact has led many to infer that there is a stated periodicity in its returns in such immense numbers; but the natural history of the worm confutes such an idea, while the records give no foundation for the inference. The sudden increase or decrease of this, as of other species of noxious insects, depends on climatic, as well as on other equally potent influences.

[Fig. 12.]

The egg, (Fig. 12, *a*), according to Dr. Phares is shaped "precisely like a scull-cap, with rows of pinheads from base to apex as thickly set as possible," appearing as if moulded in a very deep saucer. These eggs are of a translucent green color, and are deposited upon the under side of the leaves, and from their small size, are naturally difficult of detection. Each female moth deposits from 400 to 600, and according to the late Thomas Affleck, of Brenham, Texas, they hatch two days after being deposited, if the weather be moist and warm. The worms (Fig. 12 *b*, ½ grown) at first feed upon the parenchyma or soft fleshy parts of the leaves, but afterwards devour in-

*Patent Office Rep., 1855, p. 74.

differently, not only any portion of the leaves, but also the blossom-bud and blossom, together with the calyx leaves at the base of the boll, thus causing the lobes which hold the cotton, to fall entirely back and allow the cotton to drop at the slightest touch. While young these worms readily let themselves down by a web when disturbed, but when older they make less use of this web, and jerk themselves away to a considerable distance when suddenly touched. They cast their skins at five successive periods, and come to their growth in the incredibly short space of fifteen or twenty days. Mr. Affleck even states that they usually enter the chrysalis state on the eleventh day after hatching; but I incline to believe that such a brief larval existence is extremely exceptional, and the length of time required for them to mature will not only differ in different individuals of the same brood, but will vary with the state of the atmosphere. At Figure 12 *c* is given a side view, and at *d* a back view of a full-grown worm. It has the normal complement of legs—namely 16—but the two foremost pair of false legs, or those under segments 6 and 7, are so reduced in size that they are scarcely used in motion, and it consequently loops when walking.

I have upon two occasions received full-grown specimens of this worm, and they differ materially, both in depth of shade, coloration and markings, as indeed do almost all the larvæ of moths belonging to the same (*Noctua*) family. The most common color is light green, though they are frequently quite dark with a purplish hue at the sides, and with black backs. Whether light or dark colored, however, they are more or less distinctly marked with pale longitudinal lines and black spots, as in the above figures.

Mr. Lyman, in his "Cotton Culture," says of this insect: "The first moths that visit a crop deposit their eggs and die. These eggs in ten days become little worms, which fall to eating the leaf on which they were hatched, and as they grow, consume the plant and pass to another. But age comes on apace with these ephemeral creatures; the worm presently grows weary of devouring, selects a leaf, rolls himself in a little cocoon and *dies*." Of course this is a serious mistake to think that the worm dies, else how could it produce the moth which, as Mr. Lyman himself shows, afterwards issues from the cocoon. It is astonishing to find such gross errors creeping into our popular works, but then, the study of these contemptible little Bugs, even if they do sometimes totally destroy the crop, is of course beneath the dignity of the man who can write a work on cotton culture!! The truth of the matter is that, when they have completed their growth, the worms fold over the edge of a leaf (Fig. 12 *e*), and, after lining the inside with silk, change to chrysalids (Fig. 12 *f*), which are at first green, but soon acquire a chestnut-brown color; after remaining in this last state (in which, though the insect is inactive, it is yet full of life, and undergoing wonderful development) from seven to fourteen days, or even longer, the moth escapes, the chrysalis being held fast within the cocoon by means of several very minute hooks with which the tail is furnished.

[Fig. 13.]

At Figure 13 *a*, this moth is represented with the wings expanded, and at *b*, with the wings closed. The general color of the upper surface is a golden-yellow inclining to buff, with a faint olive tint near the outer or posterior margin. The fore wings are crossed, as in the above figures, by more or less distinct, irregular lilac-colored lines. But the chief characteristic is a dark slate-colored, or black spot on the front wings, in which spot there are paler scales forming almost a double pupil as represented in the figures, while between this spot and the base of the wings there is a much smaller pure white dot. In general color and in the position of the larger spot, this moth bears a remarkable resemblance to that of the true Army-worm of the Northern and Middle States.

Mr. Affleck, who certainly had abundant opportunities for observing the fact, assured me that this moth rests in the position shown in Figure 13, *b*, namely, with the head downwards. He wrote on August 22d, 1868: "The Cotton moth (*Ophinsa xylina* of Harris in his correspondence with myself) never alights in any other position, or if by accident it first assumes another position, it instantly wheels around *head down*."

According to the best authority, there are three different broods of worms during the year, the first appearing in June or July, and the last, which does the most damage, appearing in August or September, or even later. Mr. Lyman, in the little work already referred to, says: "That nature has made no provision by which either the fly, the worm, the chrysalis or the eggs, can survive the winter or exist for any length of time where the cotton plant is not a perennial." But this is surely an error, which Mr. Lyman would never have made, had he possessed a better knowledge of insect-life; and as Mr. Glover found that the chrysalis was killed by the slightest frost, the insect evidently winters over in the moth state, as do many others belonging to the same tribe. Mr. W. B. Seabrook gives strong evidence that this is the case, in a "Memoir on the Cotton Plant," read in 1843, before the State Agricultural Society of South Carolina, wherein he says: "That the Cotton Moth survives the winter is nearly certain. An examination of the neighboring woods, especially after a mild winter, has often been successfully made for that purpose." And Dr. Phares states positively that the moth hybernates in piles of cotton seed under shelter, under bark and in crevices of trees in dense forests and other secluded places, and that it may often be seen on pleasant days in winter.

The two principal remedies which have hitherto been relied upon are, 1st, hand-picking; 2d, destroying the moths by fires, to which they are naturally attracted. The first method is sure, but tedious and somewhat impracticable on a very large scale. The second is most effectual if carried out when the first moths appear, in May and June. If these two methods were persistently carried out in the early part of the season throughout any given cotton-growing county, they would of themselves be sufficient to save the crop; but the efforts of individuals are of no avail, where there are slovenly neighbors who neglect to perform these labors. It would therefore be of incalculable advantage, if something could be applied to the plants which would prevent the moths from depositing their eggs upon them, as the industrious planter could then set at defiance his more slovenly neighbor. Mr. Affleck was enthusiastic in his praise of cresylic soap as such a plant-protector, and I received a long letter, written a few weeks previous to his death, and showing how he had found that no cotton moth had ever deposited an egg on any plant that had been sprinkled with a solution of this soap. But Dr. Phares states that it was pretty thoroughly tried last year, and proved a failure, though he does not give the reason why.

It is some little consolation to know that the character of the season determines their numbers, and that if none make their appearance in any stage by the first of July, there is little to be feared from them the rest of that year.

Third—There is in the South another insect (*Laphrygma frugiperda*, Sm. & Abb.?) which is frequently known by the ominous name of "Army worm;" an insect which also will attack cotton, though it prefers grasses and weeds. This species in its habits resembles the true Army-worm of the Middle States, more closely perhaps than does the Cotton Army-worm, and Mr. Joseph B. Lyman, in his recent work on "Cotton culture"* (p. 92), calls it *the* "Army-worm;" yet to prevent confusion, the cognomen should be discontinued, and the term "Southern Grass-worm" (by which it is already very generally known) should be strictly applied to this third bogus Army-worm. We now come to the veritable Army-worm of the Northern and Middle States —the insect which is the subject of this article, and we will dwell for a few moments on the

PAST HISTORY OF THE TRUE ARMY-WORM.

If we trace back the history of the Army-worm in this country, we find that inaccuracy and confusion characterize most of the records concerning it previous to the year 1861. In that year, however, by the contemporaneous observations and experiments of several entomologists, in different sections of the United States, its natural history was first made known to the world, and the parent moth identified.

* Cotton Culture, by J. B. Lyman, late of Louisiana. Orange Judd & Co., New York.

The very earliest record which we find of its appearance in this country is in Flint's 2nd Report on the Agriculture of Massachusetts, where it is stated that in 1743 "there were millions of devouring worms in armies, threatening to cut off every green thing."

In 1770 it spread over New England in alarming numbers. Dr. Fitch in his 6th Report quotes the following full and interesting account from the Rev. Grant Powers's Historical Sketches of the Coös Country in the Northern part of New Hampshire. "In the summer of 1770 an army of worms extended from Lancaster, the shire town of Coös County, N. H,, to Northfield, Mass., almost the whole length of the Granite State. They began to appear the latter part of July, and continued their ravages until September. They were then called the 'Northern Army,' as they seemed to advance from the north or north-west to the south. It was not known that they passed the highlands between the rivers Connecticut and Merrimack. Dr. Burton, of Thetford, Vermont, informed the author that he had seen the pastures so covered with them, that he could not put down his finger without touching a worm, remarking that 'he had seen more than ten bushels in a heap.' They were unlike anything that generation had ever seen. There was a stripe upon the back like black velvet, and on each side a stripe of yellow from end to end, and the rest of the body was brown. They were seen not larger than a pin, but in maturity were as long as a man's finger and of proportionate thickness. They appeared to be in great haste, except when they halted to feed. They entered the houses of the people and came up into the kneading troughs as did the frogs in Egypt. They went up the sides of the houses and over them in such compact columns that nothing of the boards or shingles could be seen. Pumpkin-vines, peas, potatoes and flax escaped their ravages. But wheat and corn disappeared before them as by magic. Fields of corn in the Haverhill and Newbury meadows, so thick that a man could hardly be seen a rod distant, were in ten days entirely defoliated by the 'Northern Army.' Trenches were dug around fields a foot deep, as a defence, but they were soon filled and the millions in the rear passed on and took possession of the interdicted feed. Another expedient was resorted to: Trenches were cut, and thin sticks, six inches in diameter, were sharpened and used to make holes in the bottom of the trenches within two or three feet of one another, to the depth of two or three feet in the bottom lands, and when these holes were filled with worms, the stick was plunged into the holes, thus destroying the vermin. In this way some corn was saved. About the first of September the worms suddenly disappeared. Where or how they terminated their career is unknown, for not the carcass of a worm was seen. Had it not been for pumpkins, which were exceedingly abundant, and potatoes, the people would have greatly suffered for food. As it was, great privation was felt on account of the loss of grass and grain."

The same writer adds that "in 1781, eleven years after, the same kind of worm appeared again, and the fears of the people were greatly excited, but this time they were few in number."

In 1790 their ravages are again recorded in Connecticut, where they were very destructive to the grass and corn, but their existence was short, all dying in a few weeks (Webster on Pestilence, I, 272.)

Their next appearance in the Eastern States was in 1817, after an interval of twenty-seven years, according to Fitch, who quotes the following paragraph from the Albany (N. Y.) *Argus:*

Worcester, *Mass.*, *May* 22*nd*, 1817.—"We learn that the black worm is making great ravages on some farms in this town, and in many other places in this part of the country. Their march is a 'displayed column,' and their progress is as distinctly marked as the course of a fire which has overrun the herbage in a dry pasture. Not a blade of grass is left standing in their rear. From the appearance of the worm it is supposed to be the same which usually infests gardens, and is commonly called the *cut worm.* * * * This same worm is also destroying the vegetation in the northern towns of Rensselaer and eastern section of Saratoga, New York. Many meadows and pastures have been rendered by their depredations as barren as a heath. It appears to be the same species of worm that has created so much alarm in Worcester county, but we suspect it is different from the cut worm, whose ravages appear to be confined to corn."

It was not until after a lapse of forty-four years from the last mentioned date, namely, in the summer of 1861, that this worm again spread over the meadows and grain fields of the Eastern States. During the interval, however, it had from time to time attracted attention in the Western States, where it often proved quite destructive. Thus, in Illinois, it is recorded as having appeared in 1818, 1820, 1825, 1826, 1834, 1841, 1842, 1845 and 1856, and according to Mr. B. F. Wiley, of Makanda, Ill., it was quite numerous and destructive in the southern part of the State in 1849, and appeared there also in 1857, though it was confined that year to limited localities.* Mr. J. Kirkpatrick, of Ohio, mentions its appearance in the northern part of that State in 1855. He says: "Last season (1855), in consequence of the heavy rains in the early part of June, the flats of the Cuyahoga, near Cleveland, were flooded. After the subsidence of the water, and while the grass was yet coated with the muddy deposit, myriads of small blackish caterpillars appeared; almost every blade had its inhabitant; no animal could feed upon it without, at every bite, swallowing several; if a new blade sprung up, it was immediately devoured, but what was most remarkable, the insects did not attempt to remove to land a foot or two higher but that had not been covered by the water."†

***Prairie Farmer*, July 18th, 1861.

†Ohio Agricultural Report, 1855, p. 350.

The year 1861 will long be remembered as a remarkable Army-worm year, for this insect was observed in particular localities throughout the whole northern and middle portion of the United States from New England to Kansas. It was first noticed in numbers sufficient to cause alarm, in Tennessee and Kentucky during the month of April ; and toward the close of the same month it appeared in the southern counties of Illinois. By the end of June it had visited nearly all portions of the latter State, proving more or less destructive to grass, wheat, oats, rye, sorghum and corn.

Its advent in Missouri was simultaneous with that in Illinois, and judging from what facts I have accumulated, it occurred very generally over this State, though recorded only in St. Louis, Jefferson, Warren, Boone, Howard and Pike counties. No mention is made of its occurrence, at this time, in any of the States or Territories west of Missouri, but to the East, scarcely a single State escaped its ravages. In many portions of Ohio it entirely destroyed the hay and grain crops, and in the eastern part of Massachusetts the damage done was reported to exceed a half million of dollars.

Singularly enough, I can find no trace of the occurrence of this insect in Missouri prior to the year 1861, and the first intelligible account of it from the pen of a Missourian, is that by Dr. Wislizenus of St. Louis, published in the Transactions of the St. Louis Academy of Science (Vol. II, No. 1, pp. 159–60). My good friend Wislizenus then erroneously supposed it to be identical with the *Bombyx graminis* of Northern Europe—an insect which commits similar devastations on the grasses and cereals in that country. But I believe he is now well aware that it is an entirely distinct species.

Since 1861 the Army-worm has never spread so generally over such a vast extent of country, though in 1865 it appeared in considerable numbers around St. Joseph in this State, and in 1866 did some damage near Quincy, Ills., as we learn from the Quincy *Whig*.

Last year it made its appearance again in vast numbers in many portions of this State, especially in St. Louis, Jefferson, Cooper, Callaway, Henry, St. Clair, Marion, Ralls, and Lafayette counties, and in some counties in Illinois and Indiana. The first intimation I received of its appearance in Missouri was the following letter sent to me by Mr. A. E. Trabue of Hannibal, under date of June 8th:

I inclose a match-box with grass and two worms, which we think are Army-worms. They are here in myriads destroying the grass. Destroyed a hundred acres of blue grass meadow in five days, and are now advancing on me. What are they and their habits?

Carbolic acid (one part acid, 20 parts water) kills them if they get a good drench with it, but is too expensive at that rate. They will cross a trail of it without injury, though they evidently dislike the smell. Have sent to town for coal tar to see if they will cross it when the ground is soaked with it. The advancing column is a half mile wide.

The hogs are very fond of them; will not notice corn when they can get Army-worms, but we have more of the latter than they can dispose of.

A. E. TRABUE.

Upon receipt of this letter, I visited Hannibal and ascertained that the worm was even more numerous around New London, and especially on the farm of Mr. A. McPike.

ITS SUDDEN APPEARANCE AND DISAPPEARANCE.

The popular idea about the sudden appearance of an insect has always been an erroneous one. The "blows" or "gentiles" in meat, "skippers" and mites in cheese, plant-lice on plants, etc., etc., are very generally supposed to have a spontaneous origin, and our sudden Army-worm invasions have very generally been accounted for in the same way, by those who know nothing of Nature's workings. Yes, and so-called *savans*—will it be credited !—have been anxious to so far tickle the popular fancy as to conceive and give birth to theories (such as that of larval reproduction) which were not one whit more sensible or tenable.

It is well known to entomologists, and the reader, by perusing the article on "Cut-worms" in my First Report, will soon become aware of the fact, that most of the larvæ of our Owlet Moths (family *Noctuidæ*) rest hidden during the day and feed in the morning and evening, or at night. They are all smooth, tender-skinned worms, and cannot endure the scorching rays of the sun. Consequently many of them live almost habitually, just under the surface of the soil, while others shelter themselves under vegetable substances during the day. Our Army-worm forms no exception to the rule, for upon closely watching the habits of the hosts I witnessed last summer in the field, and of hundreds which I had confined in breeding cages, I ascertained that they frequently hide themselves Cut-worm fashion, just under the surface of the ground, or under the plants upon which they feed. The Army-worm delights, in fact, in cool, moist and shady situations, and from the passage already quoted, from Mr. Kirkpatrick, where it is shown that the worms which swarmed on the Cuyahogo flats, did not attempt to remove to land a foot or so higher: and from further facts recorded by Dr. Fitch, it becomes evident that its natural abode is in the wild grass of our swamps, or on low lands. During an excessive dry summer these swampy places dry out, and the insect, having a wider range where the conditions for its successful development are favorable, becomes greatly multiplied. The eggs are consequently deposited over a greater area of territory, and if the succeeding year prove wet and favorable to the growth of the worms we shall have the abnormal condition of their appearing on our higher and drier lands, and of their marching from one field to another. For just so soon as the green grass is devoured, in any particular field in which they may have hatched, these worms are forced, both from hunger and from their sensibility to the sun's rays, to leave the denuded field.

Thus the fact becomes at once significant and explicable, that almost all great Army-worm years have been unusually wet, with the preceding year unusually dry, as Dr. Fitch has proved by record. The appearance of this insect last summer in the West forms no exception, for the summer of 1868 was unusually dry and hot, while that of 1869 was decidedly wet. I may remark here, in further corroboration of these views, that, as might have been expected, no Army-worms were noticed last year in the Eastern States; for though in the summer of 1868 we of the West suffered so severely from drouth, yet in the East they were blessed with the usual amount of rain-fall, and in some sections had even more than the average amount.

There is in reality nothing in the least mysterious in the sudden appearance and disappearance of the Army-worm, for the truth of the matter is, that there are a few of these insects in some part or other of the country every year, and I have for the past four or five years captured one or more specimens of the moth every fall. The eggs hatch during the early part of May, in the latitude of South Illinois and South Missouri, and the young worms may feed by millions in a meadow without attracting attention; but when they have become nearly full grown and have stripped bare the fields in which they were born, and commence to march as described above, they necessarily attract attention, for they are then exceedingly voracious, devouring more during the last three or four days of their worm-life, than they had done during the whole of their previous existence. As soon as they are full grown they burrow into the earth, and, of course, are never seen again as worms.

Their increase and decrease is dependent on even more potent influences than those of a climatic nature. The worms are attacked by at least eight different parasites, and when we understand how persistent these last are, and how thoroughly they accomplish their murderous work, we cease to wonder at the almost total annihilation of the Army-worm the year following its appearance in such hosts. In the words of the late J. Kirkpatrick "their undue increase but combines the assaults of their enemies and thus brings them within bounds again."

We must also bear in mind, that besides these parasitic insects, there are some cannibal insects, such as the Fiery Ground-beetle (*Calosoma calidum*, Fabr.) and its larva,* which prey unmercifully upon the worms, while the "Mosquito Hawks" (*Libellulæ*) and bats, doubtless destroy many of the moths. Hogs, chickens and turkeys revel in the juicy carcasses of the worms, and sometimes to such an extent that, as I am informed by Mr. T. R. Allen, of Allenton, the former occasionally die in consequence, and the latter have been known to lay eggs in which the parts naturally white, would be green when cooked. Small birds, of various kinds, and toads and frogs also,

*First Report, Fig. 34.

come in for their share of this dainty food; while the worms, when hard pushed, will even devour each other.

NATURAL HISTORY OF THE ARMY-WORM.

Previous to the year 1861, but very little accurate knowledge had been acquired respecting the habits of the Army-worm, and nothing whatever of a scientific nature had been published.

A few very observing farmers ventured to predict its appearance during very wet summers succeeding very dry ones. They did not know why this was the case, but it was a fact that they had learned from experience. It was also known that the worm attacked only the grasses and cereals, that it was gregarious in its habits, and that it disappeared suddenly, in a manner as seemingly mysterious as that in which its advent was supposed to have been made.

These few facts were about the only ones of real value, respecting the habits of this insect, that could be gleaned from the statements of those who had suffered most from its ravages; while the subject seems to have been, up to that time, entirely ignored by entomological writers.

In 1861, however, its very general appearance, and the vast amount of damage it did, attracted the attention, not only of farmers, but of several well-known entomologists, among whom may be mentioned our late friends, Walsh, of Illinois, and Kirkpatrick, of Ohio; and Cyrus Thomas, of Illinois, Dr. Fitch, of New York, and J. H. Klippart, of Ohio.

As might have been expected, diverse conclusions were arrived at, and various theories entertained by these writers, and some very spirited correspondence between Messrs. Walsh and Thomas and Walsh and Klippart may be found in old files of both the *Ohio Farmer* and the *Prairie Farmer*.

The principal point of dispute was, whether the Army-worm wintered in the egg or chrysalis state, and, as a consequence, whether it was single or double-brooded.

It is needless to follow these gentlemen in their discussions, which were frequently caustic and pungent; but sometimes partook more of the character of personal wrangling than of a calm and conscientious search after truth. Two of the five parties mentioned above, are now in their graves, and while one of those yet living—Mr. Cyrus Thomas—believed in the two-brooded character of the insect; the other two evade the question entirely. Mr. Walsh took the ground that it was single-brooded, and the experience of the past year has convinced me that he was correct.

The Army-worm, like all other insects, hatches from an egg, and this egg is evidently deposited by the parent moth at the base of perennial grass-stalks. In Southern Missouri it hatches out about the middle of April; in the central part of the State about the first, and in the northern part about the middle of May; in Massachusetts, about the middle of June, and in Maine about the middle of July. In every locality the worm goes underground about a month afterwards to assume the pupa or chrysalis state, and stays underground between two and three weeks. Hence, in the southern part of this State the moth appears about the fore part of June, and a month later in each successive locality as we go north, till in Maine, the period becomes the fore part of September. Of course, these dates will vary somewhat with the character of the seasons, and sometimes from local causes; but, broadly speaking, they will hold good.

The moths soon pair, and sometime during the summer and fall months, deposit their eggs in the positions already indicated. Many eggs are thus deposited in tame meadows, but there is little doubt in my mind that the great bulk of these eggs are deposited in low, damp situations, and if the fall should prove wet, instead of dry, many of them would perhaps get drowned out, and we should thus have another potent influence at work to decrease the numbers of the worm the succeeding year. I make this suggestion with all due consideration, for I have long since concluded that the instincts of insects, as of some of the higher animals, are not always sufficient to guard against all contingencies. It has been demonstrated beyond the possibility of a doubt, that the Plum Curculio deposits its eggs in fruit that overhangs water, and in other positions where the grub must inevitably perish; and certain flesh-flies are well known to deposit their eggs, by mistake, on flowers which have a putrescent smell. Darwin has remarked that a small South American bird (*Furnarius cunicularius*) which builds its nest at the bottom of a narrow, cylindrical hole, which extends horizontally several feet underground, is so incapable of acquiring any notion of thickness, that, although he saw specimens constantly flitting over a low clay wall, they continued vainly to bore through it, thinking it an excellent bank for their nests.* Many such instances of misdirected instinct might be cited, and they all lead me to believe that the female Army-worm moth would be just as likely to lay her eggs in situations where they would drown out, as in situations more favorable.

The above may be considered as the normal habit of the Army-worm; but exceptional individuals occur, perhaps one in a hundred, but demonstrably not as many as one in twenty, which lie in the chrysalis state all through the winter and do not come out in the moth state till the following spring. The proportion of those which lie over till spring is doubtless greater in the more northern States than it is with us. The great fault which Mr. Walsh made in his excellent paper on this insect, published in the Illinois State Agricultural Transactions for 1861, was, that he drew his lines too rigidly, and allowed of no exceptions to the rule which he laid down, of its single-broodedness. He also fell into an error in roughly estimating

*Voyage Round the World, p. 95.

the average life of the moth at from three to five weeks. I have often caught the moths, both in the fall and spring months, even in years when the worms themselves were unnoticed by farmers; and Dr. Levi Bartlett, formerly of Pesotum, Ills., informed me while he was practising in Chicago, that he had himself ascertained that they would sometimes live at least three months, and that he had often found them as late as October. We must also bear in mind that they do not all mature and issue from the ground together, even in the same locality; but that an interval of from six to eight weeks may intervene between the issuing of the first and last moths. With these facts before us it is easy to comprehend how some of the moths live long enough to deposit their eggs on newly sown fall grain, though grass meadows are more favorite resorts. It also becomes clear that the moths may sometimes lay their eggs before harvest upon growing grain, sufficiently high from the ground, for the egg to be carried off with the straw; and this accounts for several well authenticated instances of the Army-worm starting from stack-yards.

The Army-worm larva varies but little in appearance from the time it hatches to the time when it is full grown. Some specimens are a shade darker than others, but on many thousands examined, I have found the markings very uniform as represented in the annexed cut (Fig. 14). The general color is dingy black, and it is striped longitudinally as follows: On the back a broad dusky stripe; then a narrow black line; then a narrow white line; then a yellowish stripe; then a narrow sub-obsolete white line; then a dusky stripe; then a narrow white line; then a yellowish stripe; then a sub-obsolete white line; belly obscure green. Those who are more particular will find a detailed description at the end of this article.

[Fig. 14.]

The chrysalis (Fig. 15) is of a shiny mahogany-brown color, with two stiff converging thorns at the extremity, having two fine curled hooks each side of them. The general color of the moth is light reddish-brown or fawn color, and it is principally characterized by, and receives its name from, a white spot near the center of its front wings, there being also a dusky oblique line running inwardly from their tips. The accompanying illustration (Fig. 16), though darker than it should be, will show wherein it differs from the Southern Cotton Army-worm, notwithstanding the colors of the two moths are nearly alike. Our Army-worm moth was first described by the English Entomologist Haworth in the year 1810, in his *Lepidoptera Brittanica*, page 174, as *Noctua unipuncta*. Subsequently the French Entomologist Guenée

[Fig. 15.]

[Fig. 16.]

(*Noctuelites* I, p. 77) overlooking the former's description, and regarding it as a new species, named it *Leucania extranea.* Of course Haworth's name takes the precedence. It is considered a common species even in European collections, and Guenée mentions it as occurring in Brazil. A variety without the white spot occurs in Java and India, and still another, lacking the white spot, and having a dark border on the hind wings, occurs in Australia; while an occasional specimen has been captured in England. A figure is given in Stainton's Entomologist's Annual for 1860, of one captured there in 1859, but if the figure be a correct one, the specimen is much lighter than ours, and the characteristic white spot is not nearly so conspicuous.

PARASITES OF THE ARMY-WORM.

THE RED-TAILED TACHINA FLY—*Exorista leucaniæ*, Kirk.—To one who has never before seen the Army-worm in its might, the sight of the myriads as they return thwarted in their endeavors to cross, or of the living, moving and twisting mass which sometimes fills a ditch to the depth of several inches; is truly interesting. At Hannibal I was much surprised to find that fully nine worms out of every ten had upon the thoracic segments, just behind the head, from one to four minute, narrow, oval white eggs, about 0.04 inch long, attached firmly to the skin; and my companions were equally surprised when I informed them that these were the eggs of a parasite, and that every one of the worms which had such eggs attached to it, would eventually succumb to one of the maggots these eggs produced. The eggs are no doubt deposited by the mother fly just behind the head, so that the worm may not reach the young maggots when they hatch, and be enabled to destroy them with its jaws. I have found several different kinds of cut-worms with just such eggs attached invariably on the back just behind the head. They are glued so strongly to the skin of the worm that they cannot be removed without tearing the flesh.

The large two-winged parasitic flies which deposited these eggs, were wonderfully numerous, buzzing around us and about the worms like so many bees, and the moment one was caught, I recognized it as the Red-tailed Tachina Fly. This is one of the most common and abundant of the Army-worm parasites, and attacks it in widely different parts of the country. I have also bred the same fly from the Variegated cut-worm (larva of *Agrotis inermis**), and a variety of it from our common large Cecropia worm, which is often found on apple and other fruit trees. It was first very briefly and imperfectly described as *Exorista leuca*[*i*]*æ*, by the late J. Kirkpatrick, in the Ohio Agricultural Report for 1860, page 358, and was subsequently much more fully described as *Senometopia* [*Exorista*] *militaris* by Mr. Walsh, in his Army-worm paper already referred to. Of course Mr. Kirkpatrick's

*First Report, p. 72.

name has the priority, but I introduce Mr. Walsh's original description of the fly and likewise the very same figure (Fig. 17) which he used to illustrate it.

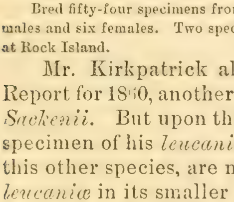
[Fig. 17.]

Exorista leucaniæ—Length, .25 to .40 inches, or from 6 to 10 millimetres, the females not exceeding .30 inch. Face silvery, with lateral black hairs only on the cheeks, at the top of which is a black bristle. Front, golden-olive, with a black central stripe, and lateral black convergent hairs. Occiput, dusky. Labium, brown, with yellowish hair. Maxipalps, rufous. Eyes, cinnamon-brown, covered with very short dense whitish hair. Antennæ, two basal joints, black, with black hairs; third joint, flattened, dusky, and from two and a half to three times the length of the second joint; seta, black. The entire hinder part of the head covered with dense whitish hair. Thorax glabrous, bluish-gray, lighter at the side, with four irregular black vittæ, and black hairs and bristles. Scutel, reddish-brown, whitish behind, glabrous, with black hairs and bristles. Pectus, black, glabrous, with hairs and lateral bristles. Legs, black, hairy; thighs, dark cinereous beneath; pulvilli, cinereous. Wings, hyaline; nervures, brownish; alulæ, opaque greenish-white. Abdomen, first joint black; second and third, opalescent in the middle with black and gray, and at the sides with rufous and gray; last joint, rufous, slightly opalescent at the base with gray; all with black hairs and lateral bristles. Beneath, the first joint is black, the others black, margined with rufous, all with black hairs. In the male the space between the eyes at the occiput is one-seventh of the transverse diameter of the head; in the female it is one-fourth. The colors of the abdomen sometimes "grease" and fade in the dried specimen.

Bred fifty-four specimens from about the same number of Army-worms. Described from eight males and six females. Two species, similarly marked with rufous, but generally distinct, occur at Rock Island.

Mr. Kirkpatrick also described on the same page of the Ohio Report for 1860, another species (?) to which he gave the name of *Osten Sackenii*. But upon the very face of it, this proves to be but a smaller specimen of his *leucaniæ;* for the characters on which he would build this other species, are none of them constant. He says it differs from *leucaniæ* in its smaller size; in the gray bands on the abdomen not being so distinct; in some little variation in the position of the brown, and in the *pulvill*[*i*]*æ* being more distinctly gray. Now *leucaniæ* varies from 0.25 to 0.40 inch in length; the brown on the abdomen is opalescent and varies; the pulvilli and gray abdominal markings vary far more in depth of shade than there set forth, and the abdomen in fact, if the least greasy, often loses all trace of gray.

[Fig. 18.]



THE YELLOW-TAILED TACHINA FLY, (*Exorista flavicauda*, N. Sp.)—We have another species in Missouri however, which may be called the Yellow-tailed Tachina Fly, and which differs so notably from the Red-tailed species that it may be recognized even on the wing. It is almost twice as large, and the head instead of being narrower than the thorax as in *leucaniæ* is broader. Its flight is also more vigorous and its buzz twice as loud, I represent this species at Figure 18, and draw up the following description for the scientific reader:

Exorista flavicauda, N. Sp.—Length, 0.35 to 0.50 inch. *Head* broader than thorax; face, silvery-white, the cheeks inclining to yellow, with lateral black hairs extending to near the base of antennæ, and one stiffer and longer bristle at top of cheeks; front, dusky, ferruginous, with two rows of black converging bristles; divided by a broad depressed stripe of a brighter ferruginous color and without bristles; occiput bright ferruginous; labium ferruginous with hairs of same color; maxipalps rufous; eyes dark mahogony-brown, and *perfectly smooth;* antennæ, two basal joints rufous, with black hairs, third joint flattened, dusky, and thrice as long as second; seta, black; entire hinder part of head covered with dense white hairs. *Thorax,* more decidedly blue than in *leucaniæ, broader* (instead of narrower) in front than behind; the vittæ less distinct; scutel of same color as thorax. *Abdomen,* stout and more cylindrical than in *leucaniæ;* first joint dark bluish-gray; second, light bluish-gray, becoming darker along the middle, at sides and at lower border; third joint, like second above, but golden-gray at sides (no rufous); last joint *entirely* yellow or pale orange, with no other color and but few black bristles around anus. *Wings* more dusky than in *leucaniæ;* alulæ, opaque bluish-white. *Legs,* black; pulvilli pale yellow.

Described from one captured, 4 bred ♀. Space between eyes at occiput fully one-third the width of head.

[Fig. 19.]

To give an idea of the other parasites which attack the Army-worm, I will briefly allude to them, and transmit descriptions for the scientific reader.

The Glassy Mesochorus—*Mesochorus vitreus,* Walsh. (Fig. 19.)—Length of body .08 inch, (two millimetres,) to .13 inch, (three millimetres); the small specimens being parasitic on the Army-worm and the large ones captured in Rock Island county. Male, general color light rufous. Eyes and ocelli, black; antennæ fuscous, except toward the base. Upper surface of thorax in the larger specimen fuscous; intermediate and posterior tibiæ with spurs equal to one-fourth of their length; posterior knees slightly dusky; tips of posterior tibiæ distinctly dusky. Wings hyaline; nervures and stigma, dusky. Abdomen, a translucent yellowish-white in its central one-third; the remaining two-thirds piceous-black, with a distinct narrow yellowish annulus at the base of the third joint. In the larger specimen, which seems to be immature, the basal abdominal joint, and the articulations of the terminal joints are light rufous. Appendiculum of the abdomen composed of two extremely fine setæ, thickened at their base, whose length slightly exceeds the extreme width of the abdomen.

The female differs from the male, in the head from the mouth upwards being piceous. The thorax and pectus, in all three specimens, are also piceous-black. Abdomen as in the smaller male. Ovipositor, which is dusky, slightly exceeds in length the width of the abdomen.

The Diminished Pezomachus—*Pezomachus minimus,* Walsh, (Fig. 20.).—Length of the body .07 to .10 inch., (2 to 2½ millimetres). Male, general color, piceous. Eyes black; antennæ black, except toward the base, where they are light rufous. Legs rufous; hind legs a little dusky. Abdomen narrowed; second and sometimes the third joint annulate with rufous at tip. The female differs from the male in the thorax being almost invariably rufous, and in the first three abdominal joints being generally entirely rufous, with a piceous annulus at the base of the third, which is sometimes absent. The abdomen is also fuller and wider. Ovipositor dusky, equal in length to the width of the abdomen. No vestige of wings in either sex, and the thorax contracted and divided as in *Formica.*

[Fig. 20.]

[Fig. 21.]

[Fig. 22.]

The larvæ of this species issue from the body of the Army-worm, and spin on its skin, small cocoons symmetrically arranged side by side, and enveloped in floss (Fig. 21). It belongs to a genus of wingless Ichneumons, and in its turn is preyed upon by a small *Chalcis* fly (*Chalcis albifrons,* Walsh) which is represented at Figure 22.

The Military Microgaster—*Microgaster militaris,* Walsh, (Fig. 23).—Length 0.07 inch. Head black; palpi whitish; antennæ fuscous above, light brown beneath towards the base. Thorax black, polished, with very minute punctures. Wings hyaline; nervures and stigma fuscous; lower nervure of marginal, and exterior nervure of second submarginal cellule entirely obsolete. Lower nervule of third and terminal submarginal cellule, hyaline. Legs light rufous, posterior pair, with knees and tips of tibiæ fuscous. Abdomen black, glabrous, highly polished. Ovipositor not exserted.

[Fig. 23.]

The cocoons of this little parasite are spun in irregular masses, and are so completely covered with loose white silk that as a whole they look like little pieces of fine wool attached to the back of the Army-worms. They were very numerous last year in this State, and were sent to me by several correspondents, under the supposition that they were the eggs of the Army-worm. Nothing could be more unsafe and erroneous than such a conclusion; for instead of giving birth to new generations of the Army-worm they produce the little flies which are its most deadly foes. All the numerous specimens which I bred accord exactly with the above named species. This parasite is also in its turn infested by two parasites (*Glyphe viridascens* (Fig. 24) and *Hockeria perpulcra*, Walsh), but while over 90 per cent. of Army-worms are killed by primary parasites, only about 18 per cent. of these primary parasites are destroyed by the secondary parasites.

[Fig. 24.]

THE PURGED OPHION—*Ophion purgatus*, Say*.—Body pale honey-yellow, somewhat sericeous; antennæ rather longer than the body; orbits yellow, dilated before, so as to occupy the greater part of the hypostoma; ocelli large, prominent; wings hyaline; stigma slender; first cubital cellule with two opaque, subtriangular spots; no areolet; metathorax with a single, raised, rectilinear, transverse line, near the base. Length, seven-tenths of an inch.

[Fig. 25.]

This large Ichneumon Fly (Fig. 25) has been bred from the Army-worm. The ovipositor is very short, and instead of piercing the skin of her victim as do all the other Ichneumons that have been described, the female Ophion simply attaches her egg, which is bean-shaped, by a pedicle to the skin. The footless grub which hatches from this egg does not entirely leave the egg-case, but the last joints of its body remain attached to the shell, while it reaches over, and with its sharp jaws gnaws into the side of the worm (Packard). This Ophion has been taken in Maine, New York, Massachusetts, Indiana, Illinois, Missouri and Carolina and doubtless occurs all over the United States.

THE ARMY-WORM ICHNEUMON FLY—*Ichneumon lucaniæ*, Fitch.—Dr. Fitch* has briefly described another true Ichneumon Fly under the above name, which he bred from the Army-worm.

Thus we have seven distinct and true parasites which attack this worm, and besides these, two others, undescribed, are figured in Harris's Injurious Insects (last edition p. 630), swelling the number to nine. Can we longer wonder that this dreaded foe to the farmer, never molests his crops for two successive years?

HABITS OF THE ARMY-WORM, AND SUGGESTIONS FOR ITS DESTRUCTION.

Since the great bulk of the eggs of the Army-worm are deposited in the summer and fall months in grass swamps and grass mead-

* *Ophion purgatus*, Say.=*O. lateralis*, Brullé.
*N. Y. Reports, Vol. III, p. 126.

ows, and the eggs do not hatch out till the following spring, it becomes obvious that burning over grass meadows in the winter or very early in the spring, must destroy most of the eggs. Many instances might be given where, in past years, burnt grass escaped the worm, while all the unburnt grass in the neighborhood was badly infested, and in one instance part of a meadow having been accidentally burnt and part remaining unburnt, the burnt portion in the following summer, had no Army-worms on it, and the unburnt portion swarmed with them. Thus, if you burn your meadows over annually you will seldom be troubled with this pest, and if you get your neighbors to do the same thing, and in addition will also burn all the wild grass around you, the Army-worm will never do you any damage. The remedy is so simple that all can apply it. The best time to do this burning, is, as all practical men well know, in the dead of the year, when the ground is frozen; the roots of the grass are then unharmed by the fire. Of course, ploughing the land late in the fall or late in the spring, will have the same effect as burning it, for if the eggs are turned two or three inches underground they will surely rot and fail to hatch. Here we see, as in the case of the Canker-worm, which I shall presently treat of, and as in the case of almost every other noxious insect, it is necessary accurately to investigate the habits and puculiarities of each one before we can effectually counterwork it.

During my visit to Hannibal last June, I ascertained that the worms orignated in a large 100-acre field of very rich blue-grass, belonging to Mr. W. R. Flowerree. This gentleman makes a business of fattening cattle, and intended feeding off the grass in the fall; but that same blue-grass field *had neither been pastured nor plowed the year before;* and this was the very reason why the worms originated there, as the reader will readily perceive from the foregoing account of the insect's habits.

The Army-worm when traveling will scarcely turn aside for anything but water, and even shallow water-courses will not always check its progress; for the advance columns will often continue to rush head-long into the water until they have sufficiently choked it up with their dead and dying bodies, to enable the rear guard to cross safely over. I have noticed that after crossing a bare field or bare road where they were subjected to the sun's rays, they would congregate in immense numbers under the first shade they reached. In one instance I recollect their collecting and covering the ground five or six deep all along the shady side of a fence for about a mile, while scarcely one was seen to cross on the sunny side of the same fence. Though they will nibble at clover, they evidently do not relish it, and almost always pass it by untouched. They will eat any of the grasses, and are fond of oats, rye, sorghum, corn and wheat, though they seldom devour any other part but the succulent leaves. They often cut off the ears of wheat and oats and allow them to fall to the ground, and they are perhaps led to perform this wanton trick, by the succulency of the stem immediately below the ear. South of latitude 40° they generally appear before the wheat stalks get too hard, or early enough to materially injure it; but north of that line, wheat is generally too much ripened for their tastes, and is sometimes even harvested before the full grown worms make their advent.

I have heard of the Army-worm, sometimes passing through a wheat field when the wheat was nearly ripe, and doing good service by devouring all the chess and leaving untouched the wheat; but the following item from Collinsville, Illinois, which appeared in the *Missouri Democrat*, contains still more startling facts, and would indicate that even a foe to the farmer as determined as this, may sometimes prove to be his friend.

"HARVEST AND CROPS.—Notwithstanding the unfavorable weather, many farmers have commenced the wheat harvest. The yield in this immediate vicinity will be superabundant. Some fields were struck with rust a few days since, but the Amry-worm making its appearance simultaneously, stripped the straw entirely bare of blades and saved the berry from injury. These disgusting pests have saved thousands of dollars to farmers in this neighborhood. A few fields of corn and grass have been partially destroyed, but by ditching around fields, the worm's ravages have been confined within comparatively narrow limits."

The worms may be prevented from passing from one field to another by judicious ditching. Mr. Trabue has large meadows, separated only by a road from the blue-grass field of Mr. Flowerree; and he thought he could keep out the worms by simply making a V-shaped ditch; believing that they could not crawl over, so long as the earth crumbled. The first evening after it was dug, this ditch seemed to be effectual, and the bottom was covered with one seething, twisting mass of the worms; but a heavy rain came on in the night following, after which they crossed without difficulty. Mr. Jas. Dimmitt however, who had 80 acres of wheat adjoining the fatal blue-grass field, effectually protected it by surrounding it with a ditch which had the inner side slanting under, towards the field it was intended to protect. It was indeed most fortunate that Mr. Dimmitt had hit upon the true method in the beginning, for his wheat was yet in that soft state, in which many of the ears would have been devoured or cut off; and friend Trabue was not long in profiting by his example.

A good plan to destroy the worms which accumulate in the furrow or ditch is to burn straw in it; for the fire not only kills the worms, but makes the earth in the ditch friable and more efficient in preventing their ascent. A heavy roller passed over a field will kill almost every worm, and I have already stated that hogs and poultry will devour great numbers of them. But it is always better and easier to prevent than to cure.

LEUCANIA UNIPUNCTA, Haw.—*Larva*—General color dingy black, with the piliferous spots, placed in the normal position, but scarcely visible, though the soft hairs arising from them are easily seen with a lens. Four lateral light lines, of almost equal thickness, and at about equal distance from each other, the two uppermost white, the two lowermost yellow; a much less distinct dorsal white line, frequently obsolete in middle of segment, and always most distinct at the divisions: a jet black line immediately above the first lateral white one, the dorsum near it, thickly mottled with dull yellow, but becoming darker as it approaches the fine dorsal white line, along each side of which it is perfectly black. Space between lateral light lines 1 and 2, dull yellow, the white lines being relieved by a darker edge; that between lines 2 and 3 almost black, being but slightly mottled along the middle; that between 3 and 4 yellow, mottled with pink-brown, and appearing lighter than that between 1 and 2. Venter greenish-glaucous, mottled and speckled with neutral color, especially near the edge of the 4th lateral line. Legs glassy and of same color as venter, those on thoracic segments with black claws, those on abdomen with a large shiny black spot on the outside. Stigmata oval, black, and placed in the 3d lateral light line. Head pale grayish-yellow, speckled with confluent fuscous dots; marked longitudinally by two dark lines that commence at the corners of the mouth, approach each other towards the centre, and again recede behind; on each side are four minute polished black eyelets, placed on a light crescent-shaped ridge, and from each side of this light ridge a dark mark extends more or less among the confluent spots above. Described from numerous average living specimens.

Imago—Front wings: general color tarnished yellowish-drab, inclining to russet; sprinkled with blackish atoms, the basal half of the costal margin being lighter than the rest. Ordinary spots brighter than rest of wing, being either fulvous or rust-red, each having ordinarily a tarnished centre, the reniform or "kidney-shaped" spot, having at its lower border a conspicuous white point, indistinctly surrounded by blackish, from which point the moth takes its name; between this point and the terminal border a transverse row of black dots (one on each vein) much arcuated above; and inside and parallel with it a less distinct row, the dots forming which, are between the nerves; an oblique dark streak, shaded off gradually posteriorly, but relieved anteriorly by the same bright color as the ordinary "spots" runs from the head of this row of dots to the apex of the wing; nerves more or less marked with white, especially towards their tips; posterior or terminal border with a row of black spots between the nerves; fringes same color as wing, with a narrow dusky line inside their middle. Hind wings partly transparent, smoky-brown, with a slight purplish lustre, the veins, lunule, and terminal border more dusky; fringes pale yellow with a dusky middle line.

Under surfaces opalescent yellowish-white, the front wings shaded with smoky-gray, the costa narrowly, and the terminal margin broadly freckled with dusky specks, the fringes and a shade near the apex flesh-color, and a distinct dusky band across their outer one-fourth, narrower but darker on the costa than in the middle of the wing: the hind wings with the lunule distinct and also speckled anteriorly and posteriorly, the basal edge of the posterior portion well defined by a series of black dots on the nerves.

Head and shoulders of same color as basal part of costa; thorax same as front wings; abdomen same as hind wings; beneath all more uniformly gray.

INSECTS INFESTING THE SWEET-POTATO.

TORTOISE-BEETLES.

(Coleoptera, Cassidæ.)

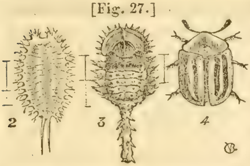
In my First Report I described eleven different and distinct insects which habitually prey on the common Irish Potato (*Solanum tuberosum*). I will now give an account of the worst insect enemies of the Sweet-Potato (*Ipomea batatus*), all of which attack that plant in this State. Before doing so, however, it will be as well to remark, that one species belonging to the same family as those which feed on the Sweet-Potato, and which is quite frequently met with in Missouri, namely, the Clubbed Tortoise-beetle (*Deloyala clavata*, Oliv. Fig. 26,)

[Fig. 26.]

feeds in reality on the common Irish Potato, thus swelling the number of insects which injuriously affect that most valuable esculent, to a round dozen. The larva of the Clubbed Tortoise-beetle is not yet known, and it is the perfect insect which has been found to attack the Potato. This is doubtless the species which Mr. Huron Burt of Williamsburg, Callaway county, referred to in the *Journal of Agriculture* of June 6th, 1868, as "a scale-like, terrapin-shaped hard insect, spread out like a flying-squirrel," that adhered tenaciously to the leaves of his potato plants. By referring to Figure 26 the reader will not be slow to learn why these beetles are called Tortoise-beetles, for the patches of dark opaque color which extend on the thin projecting semi-transparent shell of that species, remind one very forcibly of the paws of a mud-turtle. The true legs however, which, as in all other insects, are six in number, and which in this species, are so short that they scarcely reach beyond the thin shield-like crust that extends from the body, may readily be seen when the insect is turned upside down.

The insects which attack the Sweet-Potato are few in species, and belong almost entirely to this group of Tortoise-beetles. With

[Fig. 27.]



the exception of the Cucumber Flea-beetle (*Haltica cucumeris*, Harr.), figured and described on page 101 of the First Report, and a few solitary caterpillars, I have never found any other insects on this plant; but these Tortoise-beetles are of themselves sufficiently numerous in individuals and species to often entirely destroy whole fields of this esculent, and they are especially severe on the plants when newly transferred from the hot-bed.

These insects are at present included in the great CHRYSOMELA family of beetles, though they were formerly placed in a separate family (CASSIDIDÆ) by themselves, and there certainly are few groups more strongly characterized. They are almost all of a broad subdepressed form, either oval or orbicular, with the thorax and wing-covers so thoroughly dilated at the sides into a broad and flat margin, as to forcibly recall the appearance of a turtle, whence the popular name. Many have the singular power, in a greater or less degree, of changing their color when alive, and as I shall show further on, some of them shine at will with the most brilliant metallic tints.

Insects, as with the higher animals, usually void their excrement in such a manner that they effectually get rid of it, and in some cases they take pains to fling it as far from them as possible, by means of their hind legs. I have especially noticed this cleanly habit in the Oblong-winged Katydid (*Phylloptera oblongifolia*, DeGeer), of which I have had numbers breeding in confinement during the past two summers. They almost always fling their excrement straight from them, so that if they are in a horizontal position, it adheres to the sides of their cages instead of falling to the bottom. In the great majority of insects the anus is situated at, or near the last ring, and usually on the ventral side, so that the fæces are easily left behind; but the larvæ of several species of beetles that have the peculiar habit of covering themselves with their own excrement, have the anus not on their bellies, but on their backs. The Three-lined Leaf-beetle* (*Lema trilineata*) has this habit, and is enabled to cover itself by the singular position of the anal vent which is on the back of the last segment. A closely allied European species, but belonging to a different genus (*Crioceris merdigera*) has the same habit. In this country there is also another yellowish oval jumping beetle (*Blepharida rhois*, Forster), which in the larva state covers itself with its excrement. In this instance the anus is at the end of the last segment, but it is sufficiently extensile at the will of the insect to allow of the accomplishment of the feat. This last larva is a disgusting looking thing, and I found it last year very abundant along the line of the Iron Mountain Railroad, on all three of the Sumachs—*Rhus aromatica*, *glabra* and *copalina*—preferring them in the order of their naming.

But the larvæ of the Tortoise-beetles are *par excellence* the true dung carriers, for they excel all others in this medigerous art. In the instances related above, the load is carried immediately on the back, but our Tortoise-beetles are altogether more refined in their tastes, and do not allow the dung to rest on the body, but simply shade themselves with a sort of stercoraceous parasol.

The larvæ of all the species that have been observed to feed on the Sweet-Potato are broad and flattened like the beetles, and have the margin of the body furnished with spines which are often barbed, (Fig. 27, 2). They all belong to the genera *Cassida* and *Coptocycla*, and there are thirty-two of these spines, or sixteen on each side of the body. Four of these are situated on the prothorax, which forms two anterior projections beyond the common margin; four of them—the two anterior ones longer than the others—are on each of the two following thoracic segments, and each of the abdominal segments is furnished with but two. There are nine elevated spiracles each side superiorly, namely, one immediately behind the prothorax and eight on the abdominal segments. The fore part of the body is projected shield-like over the head, which is retractile and small.

[Fig. 28.]

[Fig. 29.]

In a closely allied genus (*Chelymorpha*) to which belongs a brick-red insect with black spots (*Ch. cribraria*, Fabr., Fig. 28, pupa; 29 beetle) found upon Milkweed (*Asclepias*), and which has the body greatly rounded above, with scarcely any lateral flange, the larva, as observed by Dr. Packard, has the prickles smooth and not

*First Rep., p. 100.

sprangling. In another genus also (*Physonota*) to which belongs the Five-dotted Tortoise-beetle (*Ph. quinquepunctata*, Walsh & Riley,

[Fig. 30.]

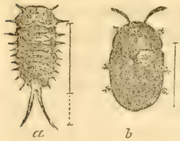


Fig. 30, *b*), and which is intermediate in form between the last named genus (*Chelymorpha*) and those with the body greatly flattened (*Cassida*, *Coptocycla*, *Deloyala*) the prickles of the larva are also smooth and only 20 in number, i. e., 10 on each side, as may be seen by referring to Figure 30, *a*. Mr. Walsh found this insect in Northern Illinois, and though we do not know upon what particular plant it feeds, yet from analogy we may infer that it subsists on some Composite flower, as other species belonging to the same genus are known to do.

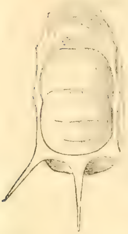
Almost all the larvæ of the beetles belonging to the great CHRYSOMELA family, of which the Colorado Potato Bug may serve as an example, have, besides the six legs at the anterior end of the body, an additional proleg, or protuberance which serves as such, at the posterior end; but the larvæ of our Tortoise-beetles have no such proleg, and the six anterior legs are short, thick and fleshy, and with the retractile head, give these larvæ, from a side view, as great a resemblance to a turtle as have the beetles.

Though lacking an anal proleg, however, they are characterized by having a movable forked tail, in the shape of two long prong-like horny filaments which both spring from a broad neck situated immediately above the anus. The anus projects and curves over the back at the will of the insect, and by the aid of this fork and of some of the lateral spines, it forms the parasol of dung which so nicely protects it.

When we read of those Hottentots who cover different portions of their bodies with the uncleaned intestines of sheep and oxen, we feel shocked at such barbarism, and can scarcely comprehend how human beings can defile themselves with the like disgusting materials. Such men must be pitiable indeed, for they can have no other object than the gratification of their filthy and beastly pleasures. There is nothing so repulsive about our insect Hottentots, for the dung parasol of our Tortoise-beetles has neither offensive odor or appearance, and its true character is generally sufficiently disguised by being intermixed with the cast-off skin and prickly spines; and though those species, first referred to, which directly cover their backs, often look sufficiently unclean, we know that they thus act at Nature's bidding and for a useful purpose.

All the Tortoise-beetle larvæ which I have bred to the perfect beetle state, have come to their growth in about three weeks after hatching. They cast their skins at three successive periods, and these skins are slipped on to the fork, where in most instances they remain. On carefully detaching from a full grown larva the dung with which these skins are mixed, these three successive skins are easily recognized, the smallest being at the extremity and the largest at the base of the fork. They are especially recognizable in the Mottled Tortoise beetle (*Cassida guttata*, Oliv., Fig. 36,) mentioned below, which removes most of its dung before each moult.

Fig. 31.



The eggs from which these larvæ hatch, are deposited singly upon the leaves, to which they are fastened by some adhesive substance. They are of irregular angular form; flat, and somewhat narrower at one end than the other; ridged above and at the sides, but smooth and obovate below. They are usually furnished with spine-like appendages, which however are sometimes entirely lacking. They look, in fact, very much like miniature specimens of those curious skate-barrows or Mermaid's purses, which are found so commonly along the sea-shore, and which are the empty egg-shells of certain kinds of Ray-fish or Skate. Those of the common Golden Tortoise-beetle (Fig. 31,) are 0.04 inch long, and of a dull, dirty white color.

The Tortoise-beetle larvæ, when full grown, fasten the last two or three joints of the body to the underside of a leaf, by means of a sticky secretion, and in about two days change to pupæ. The pupa of those species which have 32 barbed spines, is flat with usually four or five broad but thin and transparent serrated leaf-like appendages on each side of the abdomen, and the prothorax, which is greatly dilated and covers the head, is furnished around the edge with smaller barbed spines. The broad leaf-like spines at the edges of the body are bent under while the transformation is being effected, but are soon afterwards stretched stiffly out with a forward slant. The pupa loses the pronged tail, but as the old larval skin is left adhering to the terminal segments the prong of dung still protects it in most cases. The legs and antennæ are not free in this, as in the pupæ of most other beetles, but are soldered together as in the chrysalis of a butterfly, and yet it has the power of raising itself up perpendicularly upon the tail end by which it is fastened. The pupa state lasts about a week.

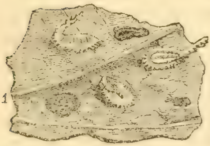
Having thus spoken in general terms of this anomalous group of beetles, I shall now refer more particularly to a few of the species. Most of those mentioned below infest the Sweet-Potato both in the larva and perfect beetle states. They gnaw irregular holes and when sufficiently numerous entirely riddle the leaves. They usually dwell on the underside of the leaves, and are found most abundant during the months of May and June. There must be several broods during the year, and the same species is often found in all stages, and of all sizes at one and the same time. In all probability they hybernate in the beetle state.

I have proved by experiment that Paris green—one part of the green to two of flour—when sprinkled under the vines, will kill these insects, though not near so readily as it does the Colorado Potato

Bug. Moreover, as these Tortoise-beetles usually hide on the under side of the leaves, and as the vines trail on the ground, it is very difficult to apply the powder without running some risk from its poisonous qualities. I therefore strongly recommend vigilance when the plants are first planted, and by the figures and descriptions given below the reader will be enabled to recognize and kill the few beetles which at that time make their appearance, and thus nip the evil in the bud. The Bermuda and Brazilian Sweet-Potato plants are more vigorous than the Nansemond, and less liable to be attacked.

THE TWO-STRIPED SWEET-POTATO BEETLE—*Cassida bivittata,*, Say.

[Fig. 32.]



This is the most common species found upon the Sweet-Potato, and seems to be confined to that plant, as I have never found it on any other kind. Its transformations were first described by myself in the *Prairie Farmer Annual*, for 1868, (p. 53.) The larva (Fig, 27, 2 enlarged; Fig. 32, natural size), is dirty-white or yellowish-white, with a more or less intense neutral-colored longitudinal line along the back, usually relieved by an extra light band each side. It differs from the larvæ of all other known species in not using its fork for merdigerous purposes. Indeed, this fork is rendered useless as a shield to the body, by being ever enveloped, after the first moult, in the cast-off prickly skins, which are kept free from excrement. Moreover, this fork is seldom held close down to the back, as in the other species, but more usually at an angle of 45° over or from the body, thus suggesting the idea of a handle. In Kirby & Spence's Introduction (p. 426), may be found the following passage in reference to the positions in which the fork of the larvæ of these Tortoise-beetles is carried: "The instrument by which they effect this is an anal fork, upon which they deposit their excrement, and which in some is turned up and lies flat upon their backs; and in others forms different angles, from very acute to very obtuse, with their body; and occasionally is unbent and in the same direction with it." Reaumur is referred to as authority for these statements, and the language would lead us to suppose that the forks were thus variously carried by different species; but Reaumur never said anything of the sort. His language has been poorly rendered, for he distinctly referred to the different positions which the same insect could give to the fork, and I believe that the peculiarity mentioned above has never been observed in the larvæ of any other species of the genus.

When full fed, this larva attaches itself to the underside of the leaf, and in two days the skin bursts open on the back, and is worked down towards the tail; when the pupa, at first pale, soon acquires a dull brownish color, the narrow whitish tail, which still adheres posteriorly, being significant of the species. See (Fig. 27, 3.)

The beetle (Fig, 27, 4) is of a pale yellow, striped with black, and though broader and vastly different scientifically, still bears a general resemblance to the common Cucumber-beetle (*Diabrotica vittata*, Fabr.)

These beetles may be seen quite thick around young peach and apple trees quite early in the season, and a little later they venture into the trees and pair off; but as soon as the Sweet-Potato plants are set, they leave everything else for them.

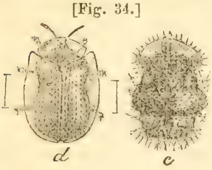
THE GOLDEN TORTOISE-BEETLE—*Cassida aurichalcea*, Fabr.

Next to the preceding species, the Golden Tortoise-beetle is the most numerous on our sweet-potatoes; but it does not confine its injuries to that plant, for it is found in equal abundance on the leaves of the Bitter-Sweet and on the different kinds of Convolvulus or Morning Glory. The lava (Fig. 33, *a*, natural size *b*, enlarged with the dung taken from the fork), is of a dark brown color with a pale shade upon the back. It carries its fæcifork directly over the back, and the excrement is arranged in a more or less regular trilobed pattern. The loaded fork still lies close to the back in the pupa, which is brown like the larva, and chiefly characterized by three dark shades on the transparent prothorax, one being in the middle and one at each side, as represented at Figure 34, *c*.

[Fig. 33.]

The perfect beetle (Fig. 34, *d*), when seen in all its splendor, is one of the most beautiful objects that can well be imagined. It exactly resembles a piece of golden tinsel, and with its legs withdrawn and body lying flat to a leaf, the uninitiated would scarcely suppose it to be an insect, did it not suddenly take wing while being observed. At first these beetles are of a dull deep orange color, which strongly relieves the transparent edges of the wing-covers and helmet, and gives conspicuousness to six black spots, two (indicated in the figure) above, and two on each side. But in about a week after they have left the pupa shell, or as soon as they begin to copulate, they shine in all their splendor, and these black spots are scarcely noticed.

[Fig. 34.]

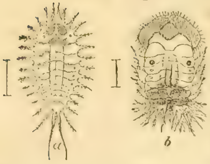


THE PALE-THIGHED TORTOISE-BEETLE—*Cassida pallida*, Herbst.

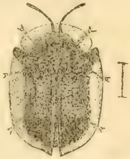
This species can scarcely be distinguished from the preceding. It is of a somewhat broader, rounder form, and differs in partially lacking the black spots on the wing-covers, and in having the thighs entirely pale yellow, while in *aurichalcea* they are black at the base. It likewise feeds upon the Sweet-Potato, and its larva differs only from that of the former, in its spines being brighter and lighter colored, and in having a dull orange head, and a halo of the same color on the anterior portion of the body.

THE MOTTLED TORTOISE-BEETLE—*Cassida guttata*,* Oliv.

[Fig. 35.]



[Fig. 36.]

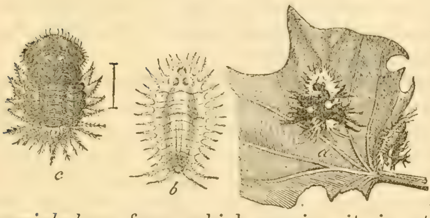


This species (Fig. 36) which is the next most common of those found on the Sweet-Potato in the latitude of St. Louis, is at once distinguished from all the others here described, by being usually black, with the shoulders black to the extreme edge of the transparent wing-covers. It is a very variable species, and is frequently more or less speckled or mottled with gold, while more rarely it has a uniform golden appearance.†

The larva, which is represented enlarged and with the dung removed at Figure 35, *a*, is of a uniform green color, with a bluish shade along the back, which shade disappears however whenever the insect has fasted for a few hours. It carries its dung in irregular broad masses, often branching as in the species next to be described. The pupa (Fig. 35, *b*,) is also of a uniform green color, with a conspicuous black ring around the base of the first abdominal pair of spiracles. Before changing to pupa and previous to each moult, this larva is in the habit of removing the dung from its fork.

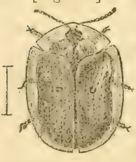
THE BLACK-LEGGED TORTOISE-BEETLE—*Cassida nigripes*, Oliv.

[Fig. 37.]



This species, which is likewise found on the Sweet-Potato, is a little the largest of those heretofore mentioned. The beetle (Fig. 38) has the power, when alive, of putting on a golden hue, but is not so brilliant as *C. aurichalcea*, from which species it is at once distinguished by its larger size and by its black legs and three large conspicuous black spots on each wing-cover. The larva (Fig. 37, *b*,) is of a pale straw color with the spines, which are long, tipped with black; and besides a dusky shade along each side of the back, it has two dusky spots immediately behind the head, and below these last, two larger crescent marks of the same color. The dung is spread in a characteristic manner, extending laterally in long shreds or ramifications. (See Fig. 37, *a*.) The pupa

[Fig. 38.]



* This insect is referred by Boheman to the genus *Co tocycla*, which differs from *Cassida* by more slender, not distinctly clavate and nearly filiform antennæ.

† This species has very probably been described under different names. It is *C. cruciata*, Fabr.; *C. signifer*, Herbst, and from larvæ found on the same batch of plants, and differing in no respect whatever, I have bred specimens which were determined by Le Conte as *C. trabeata*, Lec.

(Fig. 37, *c*,) is dark brown, variegated with paler brown as in the figure, while the spines around the edges are transparent and white.

THE PICKLE WORM—*Phacellura nitidalis*, Cramer.

(Lepidoptera, Margarodidæ.)

As long ago as the year 1828, Dr. T. W. Harris described and named the common Squash Borer (*Ægeria* [*Trochilium*] *cucurbitæ*). This borer is a true caterpillar, having sixteen legs, and very much resembling the common Peach Borer. It is hatched in the early part of summer, from eggs placed by the parent moth on the stems of the vine, close to the root. It penetrates the stem, and by devouring the pith, frequently causes the death of the vine. When full fed it retreats a short distance into the ground and forms a cocoon of a gummy substance covered with particles of earth. Within this cocoon it passes the winter, and early the next summer issues as a moth. This moth is very beautiful, with a conspicuous orange-colored body spotted with black; with the front wings blue-black and with the hind wings perfectly transparent.

Ever since the day when it was first described by Harris, this insect has been known as the Squash Borer. It seems to be confined, however, to a few of the more Eastern States, and although Mr. Wm. Klussman, of Pine Bluff, Arkansas, thinks he is troubled with this species, and has given up the growing of all winter squashes in consequence of its ravages (*Country Gentleman*, Nov. 11, 1869, page 378), yet it certainly is not of common occurrence in the Valley of the Mississippi, or we should more often hear of it.

There is, however, another borer which attacks the roots of cucurbitaceous vines, and which is but too common all over the country. I refer to that ubiquitous little pest the Striped Cucumber-beetle (*Diabrotica vittata*, Fabr.) an insect which annually destroys thousands of dollars' worth of vines in the United States, and for which remedies innumerable—some sensible, but the greater portion not worth the paper on which they are printed—are published every year in our different agricultural papers.

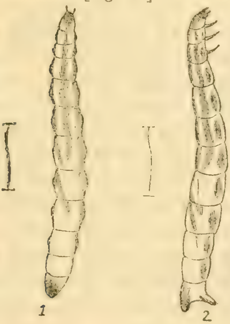
The natural history of this "Striped Bug," as it is more commonly called, was first made known in the West by Dr. Henry Shimer, of Mt. Carroll, in the *Prairie Farmer*, for August 12, 1865. But as everything pertaining to such a very common and destructive insect, cannot be too often repeated, I will here relate its habits in the briefest manner.

[Fig. 39]

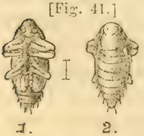
The parent beetles (Fig. 39) make their appearance quite early in the season, when they immediately commence their work of destruction. They frequently penetrate through the cracks that are made by the swelling and sprouting of the seeds of melons, cucumbers, or squashes, and by nipping off the young sprouts, destroy the plant before it is even out of the ground.

Their subsequent work when the vines have once pushed forth their leaves, is too well known to need description. Yet notwithstanding the great numbers and the persistency of these beetles, we finally succeed, with the proper perseverance and vigilance, in nursing and protecting our vines, till we think they are large enough to withstand all attacks. Besides, by this time, the beetles actually begin to diminish in numbers, and we congratulate ourselves on our success. But lo! All of a sudden, many of our vines commence to wilt, and they finally die outright. No wound or injury is to be found on the vine above ground, and we are led to examine the roots. Here we soon discover the true cause of death, for the roots are found to be pierced here and there with small holes, and excoriated to such an extent, that they present a corroded appearance. Upon a closer examination the authors of this mischief are easily detected, either imbedded in the root, or lurking in some of the corroded furrows. They are little whitish worms, rather more than a third of an inch long, and as thick as a good sized pin; the head is blackish-brown and horny, and there is a plate of the same color and consistency on the last segment. These worms are in fact the young of the same Striped Bug which had been so troublesome on the leaves earlier in the season; and that the insect may be as well known in this, its masked form, as it is in the beetle state, I present the annexed highly magnified figures of the worm (Fig. 40), No. 1 showing a back view and No. 2 a side view. The beetles, while feasting themselves on the tender leaves of the vine, were also pairing, and these worms hatched from the eggs which were deposited near the roots by the female. When the worms have become full-grown, which is in about a month after they hatch, they forsake the roots and retire into the adjoining earth, where each one, by continually turning around and around, and compacting the earth on all sides forms for itself a little cavity and in a few days throws off its larva skin and becomes a pupa. This pupa is much shorter than was the worm, and is represented enlarged in the annexed Figure 41, No. 1 ventral view, and No. 2 back view, the hair lines at the sides showing the natural size. This pupa state lasts about two weeks, at the end of which time the skin is again moulted, and the perfect beetle form assumed. All the parts of this newly developed beetle are at first soft, but after remaining motionless in its cell, till these soft parts have acquired solidity and strength, it breaks through the walls of its prison and works itself up to the light of day.

[Fig. 40.]



[Fig. 41.]



There are from two to three generations each year, the number varying according to the latitude, or the length of the winter. To show however, how the different broods run into one another, and to prove how difficult it is to separate them by distinct lines, I will state that at Kirkwood, Mo., I found this insect abundant in its three stages of larva, pupa, and beetle, during the first days of October last. And in a large jar partly filled with earth, in which I placed a number of infested roots about that time, I to-day (Nov. 8, 1869) find both pupæ and beetles. The soil in this jar was kept as nearly as possible in the same condition as that out of doors, and as I noticed the beetles around the vines even after the first frosts, I am led to infer that, in this latitude at least, the insect often hybernates as a beetle, and not always as a pupa, as intimated by Dr. Shimer.

Of all the multifarious remedies proposed against the attacks of this insect, there are none so effectual or so cheap in the end, as inclosing the young vines in boxes which are open at the bottom, and covered with millinet on the top. Such boxes are made at a trivial cost, and if properly stored away each season after use, will last for many years. Whenever other remedies must from necessity be resorted to, there is nothing better than sprinkling the vines, early in the morning with Paris-green and flour, (one part of the green to four or five of flour) or with white hellebore. It of course follows, that if the beetles are effectually kept off, there will afterwards be no worms at the roots.

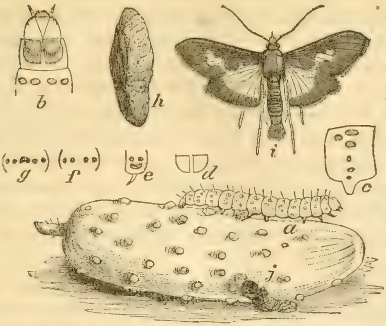
Much complaint was made last summer, in various parts of the country, of the sudden death of cucurbitaceous vines, from some unknown cause, and Henry Ward Beecher seems to have suffered in this manner, like the rest of us, but could find no worms in the roots of his vines. I know from experience that such vines are subject to a species of rot in the root—a rot not caused by insects, and for that reason the more serious, since we cannot tell how to prevent it. I have seen whole melon patches destroyed by this rotting of the roots, but in the great majority of instances where I have examined vines that had died from "some unknown cause," I have had no difficulty in either finding the worms of the "Striped Bug" yet at work on the roots, or else the unmistakable marks of their having been there. Indeed, by the time a vine dies from the effects of their gnawings and burrowings, the worms have generally become fully grown, and have hidden themselves in their little pupal cavities.

So much for the two borers which have heretofore been known to attack plants belonging to the Gourd family. We have seen how they both bore into the roots of these plants, and how one of them in the perfect state attacks the leaves. No other borers have been known to attack these plants, though the 12-Spotted Diabrotica (*D. 12-punctata*, Fig. 42), may often be found embedded in the rind of both melons, cucumbers and squashes. But we now come to a third insect which attacks plants of this same Gourd family. It neither bores into the root, nor devours the foliage, however, but seems to confine itself to the fruit; and I have

[Fig. 42]

called it the Pickle Worm, from the fact of its often being found in cucumbers that have been pickled.

[Fig. 43]



At Figure 43, *a*, I represent one of these worms of the natual size. They vary much in appearance, some being of a yellowish-white, and very much resembling the inside of an unripe melon, while others are tinged more or less with green. They are all quite soft and translucent, and there is a transverse row of eight shiny, slightly elevated spots on each segment, and an additional two behind the others on the back. (See Fig. 43, *c*.) Along the back and towards the head, these spots are larger than at the sides, and each spot gives rise to a fine hair. The specimen from which I obtained my first moth last summer was very light colored, and these spots were so nearly the color of the body as to be scarcely visible. The head was honey-yellow bordered with a brown line and with three black confluent spots at the palpi.

The cervical shield or horny plate on the first segment was of the same color as the body, and so transparent that the brown border of the head when retracted shone distinctly through it as at Figure 43, *b*. The breathing-holes or stigmata are small, oval, and of the same color as the body, with a fulvous ring around them. In some of the young worms the shiny spots are quite black and conspicuous. My late associate, Mr. Walsh, communicated to me the following description of such a marked specimen, from which he bred the very same species of moth as from the paler individuals: The description was taken when the worm was but half grown.

Length ½ inch. Color pale greenish-yellow; 16 legs. Head pale rufous, the Y-shaped sutures and the mouth black. Cervical shield as in Figure 43, *d*, each half edged with black, center rufous. Marked under shield on each side as at *e*, and the same lateral marking on joints, 2 and 3. Above on joints 2 and 3 as at *f*. On joints 4–11, eight (including 2 lateral) spots transversely arranged, and behind these, two dorsal spots. Of the eight spots the two lateral ones on each side are substigmatal. Stigmata edged with dusky. Anal joint with five spots as in *g*, the middle one large and transverse. Body with some sparse long dusky hairs, 6–8 times as long as wide, a little tapered toward the head. Spins a thread. Legs and prolegs nearly immaculate.

The worms commenced to appear in the latitude of St. Louis, about the middle of July, and they continued their destructive work till the end of September. They bore cylindrical holes into the fruit and feed on its fleshy parts. They are gross feeders and produce a large amount of soft excrement. I have found as many as four in a medium-sized cucumber, and a single worm will often cause the fruit to rot. They develop very rapidly and come to their growth in from three to four weeks. When about to transform they forsake the fruit in which they had burrowed, and drawing together portions of some leaf that lies on or near the ground, spin a slight cocoon of white silk. Within this cocoon they soon become slender brown chrysalids with the head parts prolonged, and with a very long ventral sheath which encloses the legs. If it is not too late in the season the moths issue in from eight to ten days afterwards. The late individuals, however, pass the winter within their cocoons; though, from the fact that some moths come out as late as November, I infer that they may also winter over in the moth state.

The moth produced by this worm (of which Figure 43, *i*, represents the male) is very strikingly marked. It is of a yellowish-brown color, with an iris-purple reflection, the front wings having an irregular, semi-transparent, dull golden-yellow spot, not reaching their front edge, and constricted at their lower edge; and the hind wings having their inner two-thirds of this same semi-transparent yellow. The under surfaces have a more decided pearly lustre. The thighs, the breast, and the abdomen below, are all of a beautiful silvery-white, and the other joints of the long legs are of the same tawny or golden-yellow as the semi-transparent parts of the wings. The abdomen of the female terminates in a small flattened black brush, squarely trimmed, and the segment directly preceding this brush is of a rust-brown color above. The corresponding segment in the male is, on the contrary, whitish anteriorly and of the same color as the rest of the body posteriorly, and he is, moreover, at once distinguished from the female, by the immense brush at his tail, which is generally much larger than represented in the above figure, and is composed of narrow, lengthened (*ligulate*) scales, which remind one of the petals of the common English daisy, some of these scales being whitish, some orange, and others brown. This moth was described nearly a century ago by Cramer, under the scientific name of *Phak*[*c*]*ellura nitidalis*, and it may be known in English as the Neat Cucumber Moth. The genus to which it belongs is characterized chiefly by the partly transparent wings, and by the immense scaly brush of the males. The antennæ are long, fine and thread-like, those of the male being very finely ciliated; the abdomen extends beyond the wings, and the legs are very long and slender. The species are for the most part exotic, and the larvæ of all of them, so far as known, feed on cucurbitaceous plants.

The following item, taken from a St. Louis paper, though somewhat facetious, will give an idea of the extent of the injuries caused by this insect in that vicinity:

What's the matter with the cucumbers? A lady of our acquaintance, the other day, sent to market to purchase some cucumbers for pickling purposes. They were placed in a vessel to be washed, previous to being put in the brine. It was then observed that small, singular looking worms clung in the 'wrinkles' on the outside of some of the cucumbers. These were washed off, when accident led to the discovery that inside every one of the cucumbers was secreted a white, corrugated, creeping thing, from half an inch to over an inch in length, resembling in miniature a rattlesnake's rattles, and not a very pretty object to look upon. It turns out that nearly, if not all the cucumbers brought to this market this season are affected the same way. These worms certainly do not look very good to eat, in the unpickled form; but we are told that they are entirely harmless in the natural state, and probably add to the pungency and crispness of the gherkin when forming part of the chow-chow, and other relishes which grace every well regulated square meal. Like the mites in the cheese, which with some are supposed to testify to the good quality and healthfulness of the article, we suppose worms in the pickles may fairly be considered a question of taste; but, if it is not obtrusive, we will add that we do not believe they are to *our* taste or digestion, and, if it is all the same to the cucumber merchants, we would rather not take any in our'n.

In Missouri, I have myself found this insect quite abundant in various parts of St. Louis and Jefferson counties, and the cucumbers seem to have fared worse than the melons. That it was not confined to these two counties, is also proved by the following communication which appeared in the *Journal of Agriculture*, of September 10, 1869:

Pleasant Hill, Mo., September 2, 1869. — Last winter, seeing many glowing accounts of the "Alton Large Nutmeg Melon," I sent to Mr. Barler and procured some, paying thirty cents an ounce for them; planted and worked well; during August, had some melons. The first few tasted right well, but soon my "Green Citron" cantelope ripening, the difference in the taste of the two was found to be so great that we could not eat the Alton Nutmeg. Furthermore, the latter had worms in them—the larvæ of some insect—eating into nearly every one. The Green Citron was rarely attacked by them. I have raised this variety of Green Citron for several years, and would not give one of the melons for a dozen Alton Nutmegs. It is sweet, juicy and very rich in taste. When a boy, I can remember a cantelope that was raised by my father, called "Persian." I think the Green Citron probably derived from it.

Yours, G. C. Broadhead.

In Illinois, it was very destructive around Alton, during the month of August; for, on July 19th, I received specimens from G. W. Copley, of that place, and found (Sept. 2, 1869), on visiting Mr. O. L. Barler's large melon fields, that fully three-fourths of his melons had been injured by it. Since then, several other Alton men have assured me that it was equally destructive with them. It also occurred around Springfield, for Mr. P. M. Springer sent to me, the last of October, a specimen of the moth which he had bred from a cucumber-boring worm; while Mr. Walsh also found it abundant at Rock Island, in the northern part of that State.

In Michigan, as I learned from Mr. W. B. Ransom, of St. Joseph, it greatly injured the cucumbers and melons around that place; and Mr. Glover, of the Department of Agriculture, informs me that he has found the worm on Squash, in Florida, in July. Thus it appears that this Pickle Worm has a wide range, and that last summer it simultaneously fell upon the cucumbers and melons in widely different parts of the country. Of course, in making pickles, the worm is pickled with the cucumber, and we shall consequently continue to hear startling stories about the worms in the pickles.

This insect, so far as I can ascertain, has never before been figured or described in this country; nor can I find any mention made of its destructive work in past years. I am, therefore, led to the conclusion that it was never numerous or destructive enough in the past, to attract attention. This fact becomes the more astonishing, when we consider how wide-spread and general its injuries were the past summer; and it furnishes another illustration of the sudden and enormous increase, in some particular year, of an insect which had scarcely ever before been noticed.

The system of Nature is so complicated, and every animal organism is subject to so many influences that affect its increase or decrease, that we are not surprised at the fluctuation in the relative numbers of any particular species. The "Struggle for Life," as expounded by Darwin, is no where more effectual in bringing about changes than in insect life. We are at first a little puzzled to account for the sudden advent, and the equally sudden departure of such insects as the Army-worm, Chinch Bug, Wheat Midge, etc., but when we once acquire a just conception of the tangled web in which every insect is involved, we wonder rather that the balance is so well kept.

Our Pickle-worm is an indigenous species, and has, doubtless, existed in some part or other of the country from time immemorial; and now that its habits are recorded and its history made known, I should not be at all surprised to learn that individuals have suffered from it in years gone by. The French Entomologist, Guenée, gives as its food-plant, a species of potato, and it is just possible that it may not always have fed upon the same plants on which it was found last summer. At all events, let us hope that it will disappear as suddenly as it appeared; but should it occur in great numbers again next year, the foregoing account will enable those who grow melons, cucumbers or squashes, to understand their enemy, and to nip the evil in the bud, by carefully overhauling their vines early in the summer, and destroying the first worms that appear, either by feeding the infested fruit to hogs or cattle, or by killing the worms on the spot. I know from experience that this worm when pickled with the cucumber, does not in the least affect its taste, and is not in the least injurious to the human system; but as it is not very desirable food, pickles should always be halved, before being brought to the table, especially if they were gathered from a field or garden known to be infested.

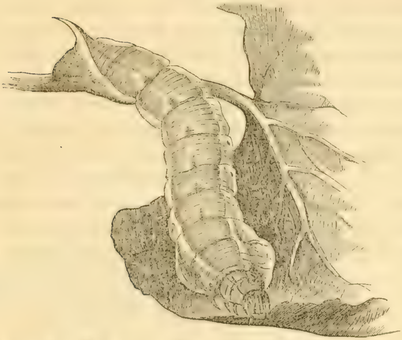
INSECTS INJURIOUS TO THE GRAPE-VINE.

Under this head, I shall continue the series of articles begun in my First Report, in order to give the grape-growers of our State a thorough understanding of their insect enemies, and thus lessen the hindrances and drawbacks to viticulture—that most important and pleasant part of rural industry, which is increasing with such unprecedented rapidity.

THE HOG-CATERPILLAR OF THE VINE—*Chœrocampa pampinatrix*, Sm. & Abb.*

[Lepidoptera, Sphingidæ.]

[Fig. 44.]



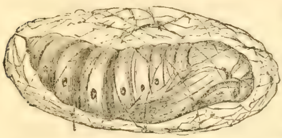
Of the large solitary caterpillars that attack the Grape-vine, this is by far the most common and injurious in the Mississippi Valley. I have frequently found the egg of this insect glued singly to the underside of a leaf. It is 0.05 inch in diameter, perfectly round and of a uniform delicate yellowish-green color. The young worm which hatches from it, is pale green, with a long straight horn at its tail; and after feeding from four to five weeks it acquires its full growth, when it presents the appearance of Figure 44, the horn having become comparatively shorter and acquired a posterior curve.

This worm is readily distinguished from other grape-feeding species by having the third and fourth rings immensely swollen, while the first and second rings are quite small and retractile. It is from this peculiar appearance of the fore part of the body, which strikingly suggests the fat cheeks and shoulders and small head of a blooded hog, that it may best be known as the Hog-caterpillar of the vine. The color of this worm when full grown is pea-green, and it is wrinkled transversely and covered with numerous pale-yellow dots, placed

*Synonyms, *Sphinx*, [*Darapsa*] *myron*, Cramer; *Otus cnotus*, Huebner. Of the four different generic names under which this species has been classified, "*Sphinx*" is a general term for all the Hawk-moths and refers to the sphinx-like attitude often assumed by their larvæ; "*Chœrocampa*" is derived from two Greek words which mean "Hog-caterpillar;" and "*Darapsa*" and "*Otus*" are gibberish. Of the three different specific names, "*Myron*" refers to an ancient Greek who bore this appellation, "*cnotus*" is pure unadulterated gibberish, and "*pampinatrix*" is from the Latin and signifies "a female vine-pruner." Both Harris and Fitch describe this insect under the name of *Chœrocampa pampinatrix;* and this, as the appellation best known to our grape-growers, and the most characteristic of the habits of the species, I should prefer to retain, although no doubt, according to the strict Law of Priority, the specific name of *Myron* ought to be employed. Mr. Walker, Dr. Clemens and Dr. Morris call this species "*Darapsa Myron,*" and Mr. Grote calls it "*Otus Myron.*" By ringing the changes with sufficient ingenuity upon the four generic and the three specific names, we may obtain no less than twelve different names for this one insect!

in irregular transverse rows. An oblique cream-colored lateral band, bordered below with a darker green, and most distinct on the middle segments, connects with a cream-colored subdorsal line, which is bordered above with darker green, and which extends from the head to the horn at the tail. There are five and often six somewhat pale yellow triangular patches along the back, each containing a lozenge-shaped lilac-colored spot. The head is small, with yellow granulations, and four perpendicular yellow lines, and the spiracles or breathing holes are orange-brown. When about to transform, the color of this worm usually changes to a pinkish-brown, the darker parts being of a beautiful mixture of crimson and brown. Previous to this change of color Mr. J. A. Lintner, of Schoharie, New York, has observed the worm to pass its mouth over the entire surface of its body, even to the tip of its horn, covering it with a coating of apparently glutinous matter—the operation lasting about two hours.* Before transforming into the pupa or chrysalis state, it descends from the vine, and within some fallen leaf or under any other rubbish that may be lying on the ground, forms a mesh of strong brown silk, within which it soon changes to a chrysalis (Fig. 45.) of a pale, warm yellow, speckled and spotted with brown, but characterized chiefly by the conspicuous dark brown spiracles and broad brown incisures of the three larger abdominal segments.

[Fig. 45.]



[Fig. 46.]

The moth (Fig. 46) which in time bursts from this chrysalis, has the body and front wings of a fleshy-gray, marked and shaded with olive-green as in the figure, while the hind wings are of a deep rust color, with a small shade of gray near their inner angle.

This insect is, in northerly regions, one-brooded, but towards the south two-brooded, the first worms appearing, in the latitude of St. Louis, during June and July, and giving out the moths about two weeks after they become chrysalids, or from the middle of July to the first of August. The worms of the second brood are full grown in September, and passing the winter in the chrysalis state, give out the moths the following May. On one occasion I found at South Pass, Illinois, a worm but one-half grown and still feeding as late as October 20th, a circumstance which would lead to the belief that at

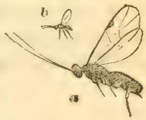
*Proc. Ent. Soc., Phil., III, p. 663.

points where the winters are mild, they may even hybernate in the larva state.

This worm is a most voracious feeder, and a single one will sometimes strip a small vine of its leaves in a few nights. According to Harris it does not even confine its attacks to the leaves, but in its progress from leaf to leaf, stops at every cluster of fruit, and either from stupidity or disappointment, nips off the stalks of the half-grown grapes and allows them to fall to the ground untasted. It is fortunate for the grape-grower, therefore, that Nature has furnished the ready means to prevent its ever becoming excessively numerous, for I have never known it to swarm in very great numbers. The obvious reason is, that it is so freely attacked by a small parasitic Ichneumon fly—belonging to a genus (*Microgaster*) exceedingly numerous in species—that three out of every four worms that we meet with will generally be found to be thus victimized. The eggs of the parasite are deposited within the body of the worm, while it is yet young, and the young maggots hatching from them feed on the fatty parts of their victim. After the last moult of a worm that has been thus attacked, numerous little heads may be seen gradually pushing through different parts of its body; and as soon as they have worked themselves so far out that they are held only by the last joint of the body, they commence forming their small snow-white cocoons, which stand on ends and present the appearance of Figure 47. In about a week the fly (Fig. 48, *a*, magnified; *b*, natural size) pushes open a little lid which it had previously cut with its jaws, and soars away to fulfil its mission. It is one of those remarkable and not easily explained facts, which often confront the student of Nature, that, while one of these Hog-caterpillars in its normal and healthy condition may be starved to death in two or three days, another, that is writhing with its body full of parasites will live without food for as many weeks. Indeed, I have known one to rest for three weeks without food in a semi-paralyzed condition, and after the parasitic flies had all escaped from their cocoons, it would rouse itself and make a desperate effort to regain strength by nibbling at a leaf which was offered to it. But all worms thus attacked succumb in the end, and I cannot conclude this article to better advantage than by reminding the Grape-grower, that he should let alone all such as are found to be covered with the white cocoons above illustrated, and not, as has been often done, destroy them under the false impression that the cocoons are the eggs of the worm. Numbers of these little white cocoons are sent to me every year under the supposition that they are eggs, and no doubt many of them get destroyed by the very persons who ought to cherish them.

[Fig. 47.]

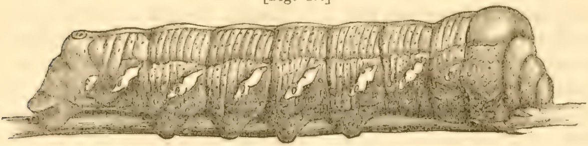
[Fig. 48.]



THE ACHEMON SPHINX—*Philampelus achemon*, Drury.*

(Lepidoptera, Sphingidæ.)

[Fig. 49.]



a

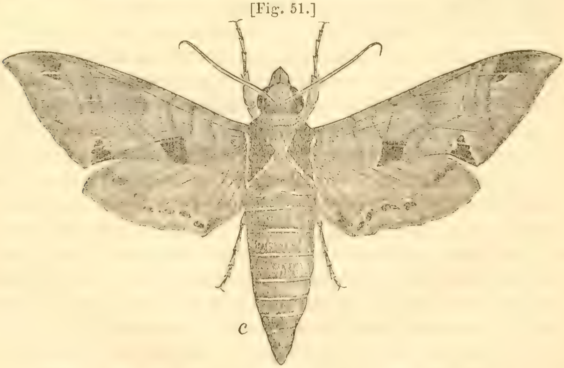
This is another of the large Grape-vine-feeding insects, belonging to the great *Sphinx* family, and which may be popularly known as the Achemon Sphinx. It has been found in almost every State where the Grape is cultivated, and also occurs in Canada. It feeds on the American Ivy (*Ampelopsis quinquefolia*, with as much relish as on the Grape-vine, and seems to show no preference for any of the different varieties of the latter. It is, however, worthy of remark, that both its food-plants belong to the same botanical Family.

[Fig. 50.]

b

The full grown larva (Fig. 49.) is usually found during the latter part of August and fore part of September. It measures about 3½ inches when crawling, which operation is effected by a series of sudden jerks. The third segment is the largest, the second but half its size and the first still smaller, and when at rest the two last mentioned segments are partly withdrawn into the third as shown in the figure. The young larva is green, with a long slender reddish horn rising from the eleventh segment and curving over the back, and

[Fig. 51.]



c

*The synonyms for this insect are *Sphinx Crantor*, Cramer, and *Pholus crantor*, Huebner. The genus *Philampelus*—meaning literally "fond of the vine"—was erected by Harris to include this and the next species.

though I have found full grown specimens that were equally as green as the younger ones, they more generally assume a pale straw or reddish-brown color, and the long recurved horn is invariably replaced by a highly polished lenticular tubercle. The descriptions extant of this worm are quite brief and incomplete. The specimen from which my drawing was made, was of a pale straw color which deepened at the sides and finally merged into a rich vandyke-brown. A line of a *feuille-morte* brown, deep and distinct on the anterior part, but indistinct and almost effaced on the posterior part of each segment, ran along the back, and another line of the same color, continuous, and with its upper edge fading gradually, extended along each side. The six scalloped spots were cream-colored; the head, thoracic segments and breathing-holes inclined to flesh-color, and the prolegs and caudal plate were deep brown. The worm is covered more or less with minute spots which are dark on the back but light and annulated at the sides, while there are from six to eight transverse wrinkles on all but the thoracic and caudal segments.

The color of the worm, when about to transform, is often of a most beautiful pink or crimson. The chrysalis (Fig. 50) is formed within a smooth cavity under ground. It is of a dark shiny mahogany-brown color, shagreened or roughened, especially at the anterior edge of the segments on the back.

Unlike the Hog-caterpillar of the Vine, just described, this insect is everywhere single-brooded, the chrysalis remaining in the ground through the fall, winter and spring months, and producing the moth towards the latter part of June. I rather incline to believe however that there may be exceptions to the rule in southerly latitudes, and that in such latitudes it may sometimes be double-brooded; for I have known the moth to issue near St. Louis during the first days of August, and have this very year found two worms in the same locality as late as the 25th of October, neither of which was quite full grown, though the leaves on the vines upon which they were found had almost all fallen. Apparently such premature development of *Sphinx* moths is a well-known occurrence among the different European species; for Chas. Darwin remarks that "a number of moths, especially *Sphinx* moths, when hatched in the autumn out of their proper season, are completely barren; though the fact of their barrenness is still involved in some obscurity.*

The moth (Fig. 51), is of a brown-gray color variegated with light brown, and with the dark spots, shown in the figure, deep brown. The hind wings are pink with a dark shade across the middle, still darker spots below this shade, and a broad gray border behind. I once had an excellent opportunity of observing how it burst open the chrysalis shell, for while examining a chrysalis, the moth emerged. By a few sudden jerks of the head, but more especially by friction

*See *Variation of Animals and Plants, etc.*, II, pp. 157–8, English Edition, and the references there given in the foot-note.

with the knees of the middle pair of legs, it severed and ruptured the thin chrysalis shell, and the very moment the anus touched the ruptured end, the creamy fluid usually voided by newly-hatched moths was discharged.

I have never found any parasite attacking this species, but its solitary habit and large size make it a conspicuous object, and it is easily controlled by hand, whenever it becomes unduly numerous upon the Grape-vine.

THE SATELLITE SPHINX—*Philampelus satellitia*, Linn.*

(Lepidoptera Sphingidæ.)

Like the preceding insect this one occurs in almost every State in the Union. It also bears a strong resemblance to the Achemon Sphinx, and likewise feeds upon the *Ampelopsis* as well as upon the Grape-vine; but the worm may readily be distinguished from the former by having five cream-colored spots each side, instead of six, and by the spots themselves being less scalloped.

[Fig. 52.]

In the latitude of St. Louis, this worm is found full grown throughout the month of September, and a few specimens may even be found as late as the last of October. The eggs of this species, as of all other Hawk-moths (*Sphinx* family) known to me, are glued singly to the leaf of the plant which is to furnish the future worm with food. When first hatched, and for sometime afterwards, the larva is green, with a tinge of pink along the sides, and with an immensely long straight pink horn at the tail. This horn soon begins to shorten, and finally

*The synonyms for this insect are *Sphinx lycaon*, Cramer; *Pholus lycaon*, Huebner, and *Daphni pandorus*, Huebner. Mr. A. Grote (Proc. Ent. Soc. Phil., I, p. 60), believes that the *Sphinx lycaon* of the authors above quoted, is distinct from *S. Satellitia*, Linn., and would fain "*eliminate*" a third species (*posticatus*). For reasons which it would be tedious to give here, I prefer to regard *lycaon* as a variety of *satellitia*.

curls round like a dog's tail, as at Figure 52, *c*. As the worm grows older it changes to a reddish-brown, and by the third moult it entirely loses the caudal horn.

When full grown, it measures nearly four inches in length, and when crawling, appears as at Figure 52, *a*. It crawls by a series of sudden jerks, and will often fling its head savagely from side to side when alarmed. Dr. Morris* describes the mature larva as being green, with six side patches; but though I have happened across many specimens of this worm during the last seven years, I never once found one that was green after the third moult; nor do I believe that there are ever any more than five full-sized yellow spots each side, even in the young individuals. The specimen from which the above figure was made, occurred in 1867, at Hermann, Missouri, in Mr. Geo. Husmann's vineyard. The back was pinkish, inclining to flesh-color; the sides gradually became darker and darker, and the five patches on segments 6—10 inclusive, were cream-yellow with a black annulation, and shaped as in the figure. On segments 2, 3, 4, 5 and 6, were numerous small black dots, but on each of the following five segments there were but two such dots. A pale longitudinal line ran above the yellow patches, and the head and first joint were uniformly dull reddish-brown.

The most common general color of the full-grown worm is a rich velvety vinous-brown. When at rest, it draws back the fore part of the body, and retracts the head and first two joints into the third (see Fig. 52, *b*), and in this motionless position it no doubt manages to

[Fig. 53.]

escape from the clutches of many a hungry insectivorous bird. Dr. Morris, copying perhaps after Harris, erroneously states that the three anterior joints, together with the head, are retracted into the *fourth*, and Mr. J. A. Lintner† makes the same false assertion. It is

*Synopsis of N. A. *Lepidoptera,* p. 178.

†Proc. Ent. Soc. Phil., III, p. 659.

the *third* segment in this species, as well as in the Achemon Sphinx, which is so much swollen, and into which the head and first two segments are retracted.

When about to transform, the larva of our Satellite Sphinx enters a short distance into the ground, and soon works off its caterpillar-skin and becomes a chrysalis of a deep chestnut-brown, and very much of the same form as that of the Achemon Sphinx, figured on page 74. The moth (Fig. 53), makes its appearance in June of the following year, though it has been known to issue the same year that it had existed as larva. In this last event, it doubtless becomes barren, like others under similar circumstances, as was shown on page 75. The colors of the moth are light olive-gray, variegated as in the figure with dark olive-green. The worms are easily subdued by hand-picking.

THE ABBOT SPHINX—*Thyreus Abbotii*, Swainson.

(Lepidoptera, Sphingidæ.)

This is another of the large Grape-feeding insects, occurring on the cultivated and indigenous vines and on the Virginia Creeper, and having in the full-grown larva state, a polished tubercle instead of a horn at the tail. Its habitat is given by Dr. Clemens, as New York, Pennsylvania, Georgia, Massachusetts, and Ohio; but though not so common as the Sphinx moths previously described, yet it is often met with both in Illinois and Missouri. The larva which is represented in the upper part of Figure 54, varies considerably in appearance. Indeed, the ground-color seems to depend in a measure on the sex, for Dr. Morris describes this larva as reddish-brown with numerous patches of light-green, and expressly states that the *female* is of a uniform reddish-brown, with an interrupted dark brown dorsal line and transverse striæ. I have reared two individuals which came to their growth about the last of July, at which time they were both without a vestige of green. The ground-color was dirty yellowish, especially at the sides. Each segment was marked transversely with six or seven slightly impressed fine black lines, and longitudinally with wider

[Fig. 54.]

non-impressed dark brown patches, alternating with each other, and giving the worm a checkered appearance. These patches become more dense along the subdorsal region, where they form two irregular dark lines, which on the thoracic segments become single, with a similar line between them. There was also a dark stigmatal line with a lighter shade above it, and a dark stripe running obliquely downwards from the posterior to the anterior portion of each segment. The belly was yellow with a tinge of pink between the prolegs, and the shiny tubercle at the tail was black, with a yellowish ring around the base. The head, which is characteristically marked, and by which this worm can always be distinguished from its allies—no matter what the ground-color of the body may be—is slightly roughened and dark, with a lighter broad band each side, and a central mark down the middle which often takes the form of an x. This worm does not assume the common Sphinx attitude of holding up the head, but rests stretched at full length, though if disturbed it will throw its head from side to side, thereby producing a crepitating noise.

The chrysalis is formed in a superficial cell on the ground; its surface is black and roughened by confluent punctures, but between the joints it is smooth and inclines to brown; the head-case is broad and rounded, and the tongue-case is level with the breast; the tail terminates in a rough flattened wedge-shaped point, which gives out two extremely small thorns from the end.

The moth (Fig. 54, below) appears in the following March or April, there being but one brood each year. It is of a dull chocolate or grayish-brown color, the front wings becoming lighter beyond the middle, and being variegated with dark brown as in the figure; the hind wings are sulphur-yellow, with a broad dark brown border breaking into a series of short lines on a flesh-colored ground, near the body. The wings are deeply scalloped, especially the front ones, and the body is furnished with lateral tufts. When at rest, the abdomen is curiously curved up in the air.

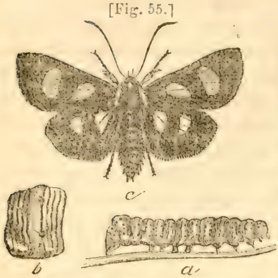
THE BLUE CATERPILLARS OF THE VINE.

Besides these large Sphinx caterpillars, every grape-grower must have observed certain so-called "Blue Caterpillars," which, though far from being uncommon, are yet very rarely sufficiently numerous to cause alarm, though in some few cases they have been known to strip certain vines. There are three distinct species of these blue caterpillars, which bear a sufficiently close resemblance to one another, to cause them to be easily confounded. The first and by far the most common with us is the larva of

THE EIGHT-SPOTTED FORESTER—*Alypia octomaculata*, Fabr.

(Lepidoptera, Zygænidæ.)

[Fig. 55.]



At Plate I, Figure 18 of my First Report, the male of this moth is illustrated by the side of its supposed larva, Figure 19 of the same Plate. In the text (pp. 136–7) I expressed some doubts as to whether this last was the rightful larva of the Eight-spotted Forester, and as I have since reared several moths from the larva state, and ascertained that the worm there figured does not belong to the Eight-spotted Forester, but in all probability to the Pearl Wood Nymph, I will now give the characters of these three different blue caterpillars, so that they may readily be distinguished hereafter.

The larva of the Eight-spotted Forester may often be found in the latitude of St. Louis as early as the beginning of May, and more abundantly in June, while scattering individuals (probably of a second brood) are even met with, but half-grown, in the month of September. The young larvæ are whitish with brown transverse lines, the colors not contrasting so strongly as in the full-grown specimens, though the black spots are more conspicuous. They feed beneath the leaves and can let themselves down by a web. The full grown larva often conceals itself within a folded leaf. It is of the form of Figure 55, *a*, and is marked transversely with white and black lines, each segment having about eight light and eight dark ones. The bluish appearance of this caterpillar is owing to an optical phenomenon from the contrast of these white and black stripes. The head and the shield on the first segment are of a shiny bright deep orange color, marked with black dots, and there is a prominent transverse orange-red band, faint on segments 2 and 3; conspicuous on 4 and 11 and uniform in the middle of each of the other segments. In the middle segments of the body each orange band contains eight black conical elevated spots or tubercles, each spot giving rise to a white hair. These spots are arranged as in the enlarged section shown in the engraving (Fig. 55, *b*), namely, four on each side as follows: the upper one on the anterior border of the orange band, the second on its posterior border, the third just above spiracles on its anterior border—each of the three interrupting one of the transverse black lines—and the fourth, which is smaller, just behind the spiracles. The venter is black, slightly variegated with bluish-white, and with the orange band extending on the legless segments. The legs are black, and the false-legs have two black spots on an orange ground, at their outer base; but the characteristic feature, which especially distinguishes it from the other two species, is a lateral white wavy band—

obsolete on the thoracic segments, and most conspicuous on 10 and 11—running just below the spiracles, and interrupted by the transverse orange band.

I quote here Harris's full description of this larva (*Correspondence*, p. 286), as it agrees with mine, except in giving the number of transverse black lines as 6 on each segment, instead of 8, from the fact that he does not include the two which border the orange band, on account of their being interrupted. I have preferred to consider each segment of this worm as 8-banded, to distinguish it more readily from the other two species, which have respectively only six and four. "Length, when at rest, one inch and two-tenths, very pale blue, transversely banded with orange on the middle of each segment, the bands dotted with small black points, producing hairs, and surmounted by black lines, and between each of the bands six transverse black lines. A large, irregular, white spot on the side of the tenth and eleventh segments, and a series of smaller white spots on each of the other segments except the first three. Head orange dotted with black. Legs blackish externally. The full-grown, have a decidedly bluish tinge, entirely owing, however, to an optical phenomenon from the contrast of the white with the transverse black lines. The head is of a pale dirty orange or rusty yellow, with about eight black dots on each side; [about 10 large and 14 small dots in all,] a semicircular plate on the top of the first segment and the anal valves are pale orange dotted with black. There is a transverse series of black dots on the second and third segments, without an orange band. Each of the other segments is transversely banded with orange and dotted with black; the dots being in two alternate rows, and all of them emitting distinct, long whitish hairs. [The anterior dots on the back of segments 4, 5 and 6 and the posterior ones on 11, are considerably larger than the rest]. Between each of the bands there are six slender, continuous, black transverse lines. The points are also connected by interrupted black lines. Legs at base orange, black externally and at tip, except the anal pair which are orange, dotted with black. The large white lateral spot is common to the side of the tenth and eleventh segments. The other lateral white spots are situated immediately behind the bands on the fourth, fifth, sixth, seventh, eighth and ninth segments, the anterior spots being largest; and thence they diminish to the ninth, while again the posterior spot is very large and very distinct. The orange bands are interrupted on the top of the seventh, eighth and ninth segments."

This larva transforms to chysalis within a very slight cocoon formed without silk, upon, or just below the surface of the earth, and issues soon after, as a very beautiful moth of a deep blue-black color, with orange shanks, yellow shoulder-pieces, each of the front wings with two large light yellow spots, and each of the hind wings with two white ones. The illustration (Fig. 55, *c*) represents the female, and the male differs from her in having the wing spots larger, and in having a conspicuous white mark along the top of his narrower abdomen.

I have on one or two occasions known vines to be partly defoliated by this species, but never knew it to be quite so destructive as it is represented in the following communication from Mr. W. V. Andrews, of New York city, which I take from the February (1869) nummer of the *American Naturalist:*

"That a man should desire to raise his own Isabellas is laudable and praiseworthy; and I see no reason why such desire should exist exclusively in the breasts of our bucolic friends. The inhabitants of New York, as a general thing, clearly are of the same opinion, as is evidenced by the number of grape-vines ornamenting the doors and trellis-work of the houses of our citizens; not, of course, in the benighted regions of Wall street, but up-town; say from Sixteenth street northward. A friend of mine residing on Thirty-fourth street, showed me, in March last, a very fine vine, which he calculated would produce him sundry pounds of choice grapes, and in the pride of his heart he invited me to "call along" occasionally, and feast my eyes on the gradual development of the incipient bunches. Thinking that August would be a good month for my visit, I "called along," wondering in my mind whether my friend would, when the time of ripe grapes came, desire me to help myself out of his abundance; or whether he intended to surprise me with a little basket of nice bunches, garnished with crisp, green leaves. The first glance at the grape-vine banished all doubts on this point. There were an abundance of bunches on the vine, in a rather immature condition, of course, but of foliage there was not a trace. Of course I expressed my surprise, though, for certain reasons, I felt none; and asked my friend why he selected a species of vine for shelter, ornament, and use, which produced no foliage. He rebuked my ignorance pretty sharply, and told me that a few weeks before, the vine was covered with leaves; but, for some inexplicable reason, they had all disappeared—eaten, he guessed, by something. He guessed right. There were at least a hundred of the larvæ of *A*, *octomaculata*, the rear guard of a mighty host, wandering about the branches, apparently for the purpose of making sure that no little particle of a leaf was left undevoured. Pretty little things they were, with harmoniously blended colors of black, yellow and blue, but so terribly destructive! I had the curiosity to walk through all the streets to the east of Third avenue, as low as Twenty-third street, and every vine was in the same predicament. If grape leaves, instead of fig leaves, had been in request for making aprons, and one *Alypia* had been in existence at the time, I doubt if in the whole Garden of Eden enough material would have been found to make a garment of decent size. The destruction of the crop for 1868 was complete.

"This was bad. But it was not half so bad as the helpless ignorance which possessed nearly all of the unfortunate owners of vines. Scarcely one that I conversed with had the remotest idea of the cause of the disaster, and when I explained that it was the caterpillar of a beautiful little black moth, with eight whitish-yellow spots on its wings, which had eaten up the foliage, my assertion was received with such a smile of incredulity, as convinced me that there is no use in trying to humbug such very sharp fellows as are the New York grape-growers.

"It is a little remarkable, however, that the destruction was confined to the eastern part of the city. I saw several luxuriant vines on the western side; and across the river at Hoboken, and at Hudson City, not a trace of *A. octomaculata* was discernible.

"The insect, then, is very local in its habits, and it is a day-flyer; and, from these facts, I infer that its ravages may be very materially checked. A little poisoned molasses, exposed in the neighborhood of the vine, would operate on the perfect insect [extremely doubtful]; while a good syringing with *soft soap* and water would bring down the caterpillars effectually."

THE BEAUTIFUL WOOD NYMPH—*Eudryas grata*, Fabr.

(Lepidoptera, Zygænidæ.)

Here is another moth (Fig. 56), surpassing in real beauty, though not in high contrast, the species just described. The front wings are milk-white, broadly bordered and marked, as in the figure, with rusty-brown, the band on the outer margin being shaded on the inner side with olive-green, and marked towards the edge with a slender wavy white line: under surface yellow, with two dusky spots near the middle. The hind wings are nankin-yellow, with a deep brown border, which does not extend to the outer angle, and which also contains a wavy white line: under surface yellow with a single black spot.

[Fig. 56.]

Surely these two moths are as unlike in general appearance as two moths well can be; and yet their caterpillars bear such a close resemblance to each other, and both feed upon the Grape-vine! The larva of the Beautiful Wood Nymph is, in fact, so very similar to that of the Eight-spotted Forester, that it is entirely unnecessary to figure it. It differs more especially from that species by invariably lacking the white patches along the sides, by the hairs arising from the black spots being less conspicuous, and by the hump on the eleventh segment being more prominent. The light parts of the body have really a slight bluish tint, and in specimens which I have found, I have only noticed six transverse black stripes to each segment. This larva, when at rest, depresses the head and raises the third and fourth segments, Sphinx-fashion. It is found on the vines in the central portion of the State as early as May and as late as September, and it devours all portions of the leaf, even to the midrid. It descends to the ground, and without making any cocoon, transforms to a chrysalis, which is dark colored, rough, with the tip of the abdomen obtusely conical, ending in four tubercles, the pair above, long and truncate, those below broad and short (Packard). Some of them give out the moth the same summer, but most of them pass the winter and do not issue as moths till the following spring.

THE PEARL WOOD NYMPH—*Eudryas unio*, Huebner.

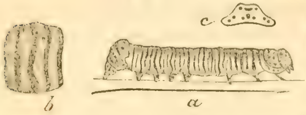
(Lepidoptera, Zygænidæ.)

This is another pretty little moth, so closely allied to, and so much resembling the preceding species, that it is not necessary to produce its picture. It is a smaller species, and differs from the Beautiful Wood Nymph in having the outer border of the front wings paler and of a tawny color, with the inner edge wavy instead of straight;

and in that of the hind wings being less distinct, more double, and extending to the outer angle.

The larva is said by Dr. Fitch to so much resemble that of the preceding species that "we as yet know not whether there are any marks whereby they can be distinguished from each other." (Report 3, § 124.) The moth is more common with us than its larger ally, and though I have never bred it from the larva, yet I have often met with a worm (Fig 57, *a*,) which there is every reason to believe, belongs to this species, and which is easily recognized from the preceding. It never grows to be quite so large as the other, and may readily be distinguished by its more decided bluish cast; by having but four light and four dark stripes to each segment (Fig. 57, *b*,); by having no orange band across the middle segments, and by the spots, with the exception of two on the back placed in the middle light band, being almost obsolete. The head, shield on the 1st segment, hump on the 11th, and a band on the 12th, are orange, spotted with black, the hump being marked as at Figure 57, *c*. Venter orange, becoming dusky towards head; feet and legs also orange, with blackish extremities, and with spots on their outside at base.

[Fig. 57.]



The worm works for the most part in the terminal buds of the vine, drawing the leaves together by a weak silken thread, and cankering them. It forms a simple earthen cocoon, or frequently bores into a piece of old wood, and changes to chrysalis, which averages but 0.36 inch in length; this chrysalis is reddish-brown, covered on the back with rows of very minute teeth, with the tip of the abdomen truncated, and terminating above in a thick blunt spine each side.

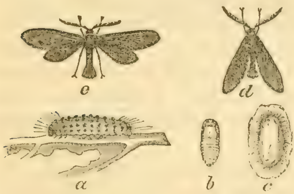
From the above accounts it is hoped that the reader will have no difficulty in distinguishing between these three blue caterpillars of the Grape-vine. But, says the practical grape-grower, "what does it concern me to know whether the little blue varmints that are defoliating my vines, belong to this species or to that? All I wish to know is how to get rid of them, and as they are all three so nearly alike, the remedy applied to one must be equally effectual with the others." Gently, dear reader; it *may* prove of considerable importance that you know which particular species infests your vines! If, for instance, a person living in the West should find the larvæ of the Beautiful Wood Nymph, then he need feel no alarm; while if a person living in the East should find that of the Pearl Wood Nymph, he may in like manner put his hands in his pockets and go his way with an easy mind; for neither of these species are likely to become troublesome in those respective sections of the country, since heretofore they have always been quite rare in those parts. Again, the larvæ of the two Wood Nymphs have a fondness for boring into old pieces of wood, to transform to the chrysalis state, and Mr. T. B. Ashton, of White Creek, New York, found that they would even bore into corn cobs for this purpose in preference to entering the ground, wherever such cobs were accessible.* The Eight-spotted Forester, on the contrary, has no such habit, and while the only mode of combating it, is to pick the larvæ off and burn them, the Wood Nymphs may be more easily subdued by scattering a few corn cobs under the vines in the summer, to be raked up and burned in the winter.

THE AMERICAN PROCRIS—*Procris* [*Acoloithus*] *Americana*† Boisd.

(Lepidoptera, Ctenuchidæ.)

During the months of July and August, the leaves of the Grapevine may often be found denuded of their softer parts, with nothing

[Fig. 58.]



but the veins, and sometimes only a few of the larger ribs left skeleton-like, to tell of the mischief that has been done. Very frequently, only portions of the leaf will be thus denuded, and in that event, if we examine such a leaf closely, we shall find the authors of the mischief drawn up in line upon the yet leafy tissue with their heads all towards the margin, cutting away with their little jaws and retreating as they feed.

[Fig. 59.]

These little soldier-like files are formed by worms in black and yellow uniforms which produce a moth popularly known as the American Procris. The eggs from which they hatch, are laid in small clusters on the underside of the leaves, and while the worms are small, they leave untouched the most delicate veins of the leaf, which then presents a delicate net-work appearance as shown at the right of Figure 59; but when they become older and stronger they devour all but the larger ribs, as at the left of the figure.

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*Fitch's Rep. III, p. 82.

†This is the *Aglaope Americana* of Clemens, *Procris Americana* of Boisduval and Harris, and *Ctenucha Americana* of Walker.

The full grown larva (Figure 58, *a*) measures rather more than half an inch, and tapers a little towards each end. It is of a sulphur-yellow color, with a transverse row of six velvety-black, prickly tufts on each of the principle segments, the lower tufts being less distinct than those on the back. The first segment is entirely black with a yellow edge, while the spots on segments 11 and 12 usually run into one another. Head small, brown, and retractile, being usually hidden in the first segment. Fine scattering hairs anteriorly, laterally and posteriorly. The young worm is of a very pale yellow, covered with numerous fine white hairs, with a slight grayish-brown tint on the head, and with the fifth and seventh segments paler than the rest, and having the black spots scarcely visible.

When full grown these worms disperse over the vines or forsake them entirely, and each spins for itself a small, tough, whitish, flattened cocoon (Fig. 58, *c*) within which, in about three days, it changes to a chrysalis (Fig. 58, *b*), 0.30 inch long, broad, flattened and of a light shiny yellowish-brown color. In about ten days afterwards the moths (Fig. 58, *e* and *d*) begin to issue. This little moth is the American representative of the European *Procris vitis;* it is wholly of a black color, except the collar, which is of a deep orange, and the body ends in a broad fan-like notched tuft, especially in the male. The wings are of a delicate texture, reminding one of crape, and when the insect is at rest they generally form a perfect cross with the body, the hind wings being completely hidden by the front ones, which are stretched out straight at right angles, as in the genus *Pterophorus*, to which belongs the Grape-vine Plume.* I have, however, on one or two occasions found the American Procris resting in the manner shown at Figure 58, *d*.

This is the only Grape-vine feeding caterpillar which has a gregarious habit, and as gregarious insects are always more easily subdued than those of a solitary nature, the American Procris need never become very destructive. Its natural food is undoubtedly the wild grape-vines of our forests, and the Virginia Creeper, and Mr. Jordon, of St. Louis, has noticed that while it very commonly attacks the foliage of the Concord, yet it never touches the Clinton and Taylor in his vineyard—a taste which is remarkable and not easily accounted for, since the foliage of the latter kinds is more tender and generally more subject to insect depredations than that of the former.

There are two broods of this insect each year with us, some of the moths from the second brood of worms issuing in the fall, but the greater part not leaving their cocoons till the following summer. During the month of June they may be seen in pairs about the vines, and I have also frequently observed around Hermann, a very closely allied but smaller and different moth (*Acoloithus falsarius*, Clem.) about the same season of the year. This last, though so closely resembling the other, may be distinguished by being scarcely more than half as large; by the body lacking the anal tuft and being comparatively much thicker and shorter; by the hind wings being comparatively larger, and by the collar being of a paler orange and divided on the top by a black point.

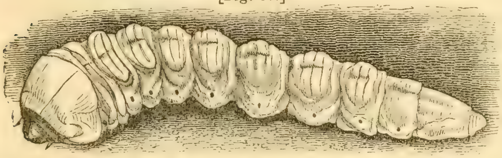
*First Rep., Pl. II, Fig. 15.

The American Procris, though the fact is not mentioned by other authors, is subject to the attack of at least one parasite, with us; for I have bred from it a very peculiar little four-winged black fly belonging to the great *Chalcis* family, and which Mr. Cresson of Philadelphia refers doubtingly to *Perilampus platygaster*, Say.

THE NEW GRAPE-ROOT BORER.

Under this head I published last year* an account of a gigantic Grape-root borer which had at that time not been bred, and of which, in consequence, the perfect insect was not with certainly known. In order that the reader may get well familiarized with its appearance, the figure is here reproduced (Fig. 60). For reasons then given I inferred that this borer belonged to the *Prionus* family of the Long-horned beetles, and that it would perhaps produce the Cylindrical Orthosoma (*Orthosoma cylindricum*, Fabr.), a large flattened bay-colored beetle which is common throughout the country, and especially so in the Mississippi Valley, and which I illustrated at the time. I expressed the hope to be able another year to settle this matter, and am glad to be able to do so.

[Fig. 60.]

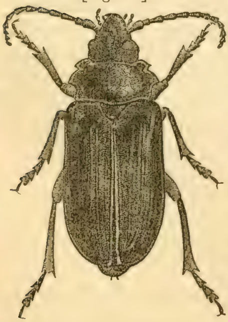


Last July I bred from worms that had been sent to me the year before, as occurring in Grape root, a different, though very closely allied species to that which I had inferred they would produce, namely,

THE BROAD-NECKED PRIONUS—*Prionus laticollis*, Drury.

(Coleoptera, Prionidæ.)

[Fig. 61.]

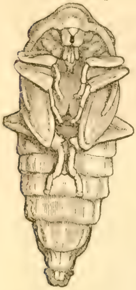


This species is usually of a darker color than the Cylindrical Orthosoma, and differs materially from that species by its larger size and broader form. The female, which is represented at Figure 61, differs from the male in having shorter and narrower antennæ, though her body is usually larger.

In all probability this insect lives nearly three years in the larva state, for three distinct sizes may be found. Those I have bred, left the roots they were inhabiting when about to become pupæ, and formed for themselves smooth oval chambers in the earth wherein they eventually cast their larval skins, and

*First Rep., pp. 124–8.

[Fig. 62.]



assumed the pupa form represented at Figure 62, but in all probability they transform within the root, when in more natural conditions. This change takes place towards the end of June, and the perfect beetle appears in about three weeks afterwards.

Soon after breeding this beetle from Grape-feeding borers, I bred a female of the same species from a very large borer which I had found the same spring, in an apple root, it having entirely killed a young apple tree, by hollowing out nearly all the roots, and by finally severing the tap root near the butt of the tree.

Thus it results that the Broad-necked Prionus bores in the larva state indiscriminately in the roots of the Grape-vine and Apple, and perhaps in those of the closely allied Pear. According to Harris it also infests the roots of different kinds of poplars, and it is consequently a pretty general feeder.

Few persons are really aware of the amount of damage these gigantic borers are capable of causing. Last March I received a long letter from Mr. Robert S. Munford, of Munfordsville, Ky., minutely describing this borer, and the manner in which it destroyed three hundred dollars' worth of his apple trees; while Mr. C. R. Edwards, of Bowling Green, Ky., writes that they have been quite injurious to his grape-vines of all varieties, though his Ionas suffered most from their attacks. Mr. Emory S. Foster, of Bushburg, sent me a specimen in May with the statement that it cut off a vine, after the fall of the leaf, and then went some six inches further down, and entered the main root, making for itself a comfortable residence where it spent the winter. Messrs. Bush and Spaulding inform me that they are continually losing vines from this borer, and that they consider it one of the worst enemies they have to contend against.

Little can be done to prevent the ravages of these underground borers after they are once in a vine, the death of which is usually the only manifestation of their presence. Still, every vine-grower should make it a rule to search for them whenever he finds vines suddenly dying from any unknown cause, and upon finding such a borer should at once put an end to its existence. The beetles, which may often be found during the summer and fall months, and which not unfrequently rush with heavy, noisy flight, into our lighted rooms, should also be ruthlessly sacrificed whenever met with. As I shall presently show, however, much may be done by judicious management to prevent their getting into the vines.

THE TILE-HORNED PRIONUS—*Prionus imbricornis*, Linn.

(Coleoptera Prionidæ.)

[Fig. 63.]

♂

There is another species, the Tile-horned Prionus (*Prionus imbricornis*, Linn., Fig. 63 ♂)—so called from the joints of the male antennæ lapping over one another like the tiles or shingles of a roof—which very closely resembles the Broad-necked Prionus, and is with us much commoner. It may be distinguished at once from this last by the antennæ of the male being about 19-jointed, and those of the female about 16-jointed;* whereas both sexes of the Broad-necked Prionus have 12-jointed antennæ. In other respects, these two beetles are almost exactly alike, so that, if the antennæ happen to be broken, it is not very easy to tell one from another.

Hitherto it has not been known upon what kind of tree this species fed, but I was fortunate enough last summer to ascertain that it also infests grape-roots. On the first of July last, Mr. Isidor Bush, of Bushburg, brought me quite a number of full-grown larvæ which he had taken from the roots of his grape vines. These were so very similar in appearance to those which produced the Broad-necked species, that I had not a suspicion they would produce anything else, and I was consequently greatly surprised when I bred from them a number of the Tile-horned species under consideration. By collecting together fibres and chips of the roots, they form a loose sort of cocoon, and transform, either inside or outside of the root, to pupæ, which resemble so closely that shown in Figure 62, that they can scarcely be distinguished from it.

We have, therefore, two distinct insects which bore into the roots of the Grape-vine, and which, though distinct, are so closely allied, that the females can only be distinguished by the number of joints in their antennæ. One of these is known to attack, besides the Grape, the Apple, the Lombardy poplar and the Balm of Gilead, and the other is very likely equally indifferent as to its choice of diet.

The accounts given in my former article, of the immense borers found in Osage Orange roots, and even in the roots of corn-stalks, undoubtedly refer to one or the other of these insects, and probably to the Tile-horned species, as that is the most common.

* Having examined nearly 20 males of this species, I have found the antennal joints to vary in number from 18 to 20, the same specimen often having a different number of joints in the right and left antenna. In one ♀ the antennæ are both of them 16-jointed, in another ♀ they are both of them 17-jointed. The typical number of joints in the Coleopterous antenna is only 11; and the number being so variable in these many-jointed antennæ is in accordance with the general rule, hat multiple parts are often variable.

t

Several persons who have recognized this immense borer from the figure and description which I published last year, have informed me that they have found it on prairie land, and Mr. Wm. C. Holmes, nurseryman, of Plattsburg, writes: "The Borer described on page 124 of your Report is destroying a good many of our apple grafts, set last spring. The root not being large enough for them to work inside, they eat out about one-third of the bark, and hollow out the rest of the root. Our nursery is on prairie, broke in the fall of 1867 and spring of 1868." Now the fact of these large root-feeding borers occurring in such numbers in recently turned-up prairie land where no large roots exist, would have been perfectly inexplicable had I not been cognizant of other facts which threw light on the subject.

There is a small dimorphous male form of the Tile-horned Prionus not more than half the normal size, and of a much paler yellowish color, which is quite common in the West, and which I have found even more common around St. Louis, than the true type. I know that this form is often found in prairie regions, and my entomological friend Chas. Sonne, of Chicago, Illinois, informs me that a relation of his, Mr. F. Jæger, of Siegel, Illinois, in digging a cellar, once found immense numbers of these large grubs near the surface of the ground. A whole lot of them were sent to Mr. Sonne, and he bred from them numerous specimens of this small form of the Tile-horned Prionus, every one of them males, and every one with nineteen joints to the antennæ. On another occasion, at the same place, Mr. Sonne, having placed a lamp on a grind-stone, found that these beetles swarmed around the light, and next day upon examining a number which he captured, they all proved to be, in like manner, the small yellow form, and all males. Now, Mr. Jæger's house is remote from any timber whatever, there being but a few scrub willows here and there near by; and, from these facts, and those mentioned by Mr. Holmes, we are forced to the belief that these grubs (at least those of the small ♂ dimorphous form) are able, not only to subsist on the roots of small shrubs and very young trees, but also upon those of herbaceous plants. Mr. H. A. Mungor, of Lone Cedar, Martin county, Minnesota, has had a similar experience; for he often ploughs up these grubs in prairie land, and has captured the beetles a full mile away from any trees or shrubs, except a few specimens of a suffruticose plant known as the Lead-plant (*Amorpha Canescens*), which very seldom grows a root there, of over one-half inch diameter. He has also actually bred the beetle from pupæ found in such prairie ground. Therefore, some of the accounts—such as their occurring full grown in the roots of annuals like corn and cabbage, and in those of grape-vines but one year planted—which were not easily explained before; become perfectly clear, now that we have a better understanding of the facts in the case.

Now then comes the point of practical importance. It may with reason be argued, that it matters little to the Grape-grower to which particular species these borers belong, so they have the habit in common, of infesting the roots of his vines. But a more important question presents itself to the thinking mind. Is any danger to be apprehended from these borers, from growing grape-vines and fruit trees among decaying oak stumps? In my former article, from the testimony of practical vineyardists, I have hinted that there is, and have advised not to plant on land covered with such stumps, or even to use oak stakes, where those made of cedar can be had; and I am glad to be able to say that this advice is well founded.

As a general rule, the larvæ of the Long-horned Boring Beetles either inhabit green and living wood or else decaying and dead wood, the same species never attacking both kinds of wood indiscriminately; and as I knew that the larva of the Cylindrical Orthosoma fed on rotten pine wood, I thought it very probable that it also fed on rotten oak stumps, and had been confounded by practical men with those of the Broad-necked and Tile-horned species, which it so much resembles. This opinion was supported by the fact that it occurred abundantly in Union county, South Illinois, in 1861, where there are no pine trees growing, and where, at that period, the so called "poplar" or white-wood was universally used in buildings, in place of pine imported from the North; and I last summer ascertained that it really does breed in rotten oak stumps, as well as in decaying pine, for I found it in the former wood, both in the larva, pupa, and fresh beetle state. But what is still more important I also find that the Broad-necked Prionus, is an exception to the rule above mentioned, and that it breeds as freely in decaying oak stumps as in living roots. For this fact I am indebted to Mrs. Mary Treat of Vineland, N. J., who has sent me specimens of the beetle bred from larvæ that are found abundant in the oak stumps in that vicinity.

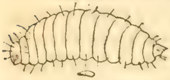
SUMMARY.—To sum up the whole matter in a few words, it is obvious that we have in Missouri three large boring grubs, which so closely resemble each other, that they cannot be distinguished by any marks which we are yet acquainted with—that the Broad-necked Prionus feeds indiscriminately on the living roots of Apple, Grapevine, Poplar (and perhaps of several other trees), and on decaying oak stumps, and will travel through the ground from one place to another—that the Tile-horned Prionus not only attacks the Grapevine, but can subsist on the roots of herbaceous plants, and in all probability will also feed on decaying oak, like the former species; and finally, that the Cylindrical Orthosoma feeds on decaying pine and oak, but has not yet been found in living roots. From these facts we may deduce the important corollary, that it will not do to leave oak stumps to rot on ground which is intended for a vineyard or orchard—which was the thing to be proved.

THE GRAPE SEED-MAGGOT—*Isosoma vitis*, Saunders.

(Hymenoptera, Chalcididæ.)

In my First Report (pp. 125–31), I gave an account of a minute maggot (Fig. 64) which had been found by Mr. Wm. Saunders, of London, C. W., to infest the seeds of growing grapes, and to occasion much damage around London and Paris, by causing the berries of the Clinton, Delaware, Rogers' No. 4, and some of Mr. Arnold's Seedlings, to shrivel up without maturing. There are so many noxious insects, common in Missouri, that occur also in the southern portions of Canada West, that it was deemed necessary to give the grape-growers of the State a diagnosis of its work, in case it should at any day make its appearance in our vineyards.

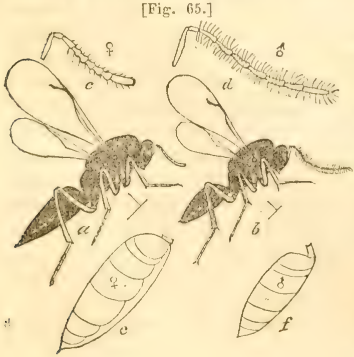
[Fig. 64.]



From the appearance of this maggot, I inferred, with every one else who gave an opinion, that it would most likely produce some small species of snout-beetle (*Curculio* family). Now mark how dangerous a thing it is, for even an entomologist to guess at the character of some insects, when in this masked form. We flatter ourselves that there are but very few insects among the half million different species that are estimated to exist in the whole extent of this terrestrial globe of ours, that we cannot place at a glance in its proper Order, even when in the larva state; but let us humbly acknowledge that there are some few larval forms among the more minute Four-winged Flies (order *Hymenoptera*) and Beetles (order *Coleoptera*) which it is almost, if not absolutely, impossible to distinguish the one from the other.

Last August I had the pleasure of spending a few hours with Mr. Saunders, at his place in London, and I was gratified to learn that he had bred the perfect insect from this seed-maggot. It proved to be a little Four-winged fly (*Chalcis* family), and upon my return home, I found a few specimens of the very same species of fly, in a bottle in which were placed some infested grapes received the year before from Mr. A. S. Fuller of New Jersey, and obtained by him from Canada.

[Fig. 65.]



This fly so closely resembles the notorious Joint-worm Fly (*Isosoma hordei*, Harris) that the accompanying highly magnified sketch (Fig. 65) of that insect—*a* representing the female, *b* the male, *c* the ♀ antenna, *d* the ♂ do., *e* the ♀ abdomen and *f* the ♂ do.—will afford a very correct idea of its appearance.

The Grape Seed-maggot Fly differs principally from the Joint-worm Fly in its somewhat smaller size, in the legs being marked with black on the thighs and shanks, in the ♂ abdomen being comparatively shorter, and in its third ring conspicuously overhanging the fourth. The following account and description from Mr. Saunders himself, is taken from the November number of the *Canadian Entomologist:*

"In October I detached a larva from the inside of the seed, and placed it in a small glass cell between two plates of glass, in which state it remained until early in January, when it became a pupa, having first attached itself to the sides of the cell by a few short silky threads. It had now contracted in length, become nearly oval, and assumed a yellowish tint, with a few short loose silky threads adhering to different parts of its surface. On the 11th of February I examined some seeds and found the larva within, still alive and active, just as it appeared in the fall. On the 7th of July further specimens were opened and the inmates found soft and motionless; these appeared to be in the pupa state, but I did not examine them with sufficient care to enable me to be positive. During the remaining part of July, I looked many times into the bottles in which the grapes were enclosed but could not discover anything. On the 9th of August, feeling sure that the time for the appearance of the insect must be fully come, if not already past, I resolved on a thorough search for it. As soon as the contents of the bottles had been emptied on a piece of white paper, I observed a number of small four-winged flies among the dried-up grapes. They were all dead and stiff, some of them more brittle than others. From the observations made, I should judge that they made their escape from the middle to the end of July."

ISOSOMA VITIS, Saunders, ♀—*Head* large, flattened in front, black, thickly punctured, and covered with many short whitish hairs; mandibles pale brown at base, tipped with black; antennæ (scape and 8 joints), 9-jointed, black, thickly covered with whitish hairs inserted in deep sockets; the scape pale brown, slender, nearly as long as the three following joints together; the second short; third to eighth inclusive nearly equal in length; the terminal joint longer, tapering slightly towards the tip. *Thorax* black, punctured and covered with whitish hairs. *Legs*, front pair pale brown, trochanters nearly black; second and third pairs, trochanters black, femora and tibiæ nearly black along the middle, pale brown at tips; tarsi pale brown. *Abdomen*, long, black, straight, smooth, with a polished surface; placed on a short pedicel; a little contracted at base, thickest on third joint, tapering gradually to fifth, and then suddenly to extremity; the basal joint very short, second and third each somewhat longer, fourth as long as the three preceding, fifth less than half as long as fourth, sixth a little shorter, terminal joint rather longer.

♂ differs from ♀ in having the antennæ somewhat longer and more thickly covered with hairs. His abdomen is short, thick and blunt, placed on a moderately stout pedicel nearly its own length. The abdominal rings have about the same relative size as in the female, but the posterior edge of third overhangs the fourth, the latter appearing as if partially drawn within the projecting edge of the third ring.

Length ♀ 0.10, ♂, 0.06 inch.

"Having kept the grapes in bottles, only occasionally opened for ventilation, in a dry room, they had become quite hard, dry and shrivelled. In consequence of this, many of the flies were unable to make their way out, the seed having become too hard for their jaws to eat through. On opening some of these the flies were found dead with wings fully developed and surrounded by small fragments of the interior coating of the seed which they had evidently gnawed off while endeavoring to escape. Those which had found their way out had eaten a small nearly round irregular hole through seed and skin. In many similar cases where the larva feeds within a hard substance it provides for the escape of the perfect insect by eating away the hard enclosure until it is reduced so thin as to appear almost transparent, then a very little effort is sufficient to remove the obstruction to the outward passage of the imago. In this instance I have been unable to detect any such preparation, and believe that the whole work of escape is accomplished by the perfect fly.

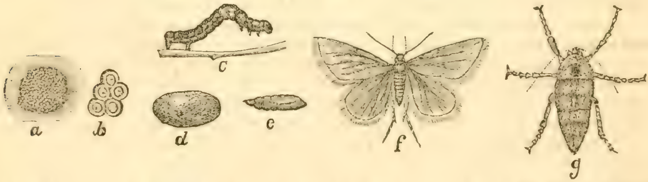
"Notwithstanding the abundance of this insect last year, I have as yet been unable to detect their presence or any evidence of their work during the present season; probably the cold and wet character of the summer has been unfavorable to their operations."

THE CANKER-WORM—*Anisopteryx vernata*, Peck.

[Lepidoptera Phalænidæ.]

This word CANKER-WORM has formed the heading of so many articles in our various Agricultural and Horticultural journals during the last ten or twelve years, and its natural history has been so fully given in the standard work of Dr. Harris, that one almost wonders

[Fig. 66.]



where there can be a reading farmer who does not know how properly to fight it. But then, new generations are ever replacing those which pass away, so that the same stories will doubtless have to be repeated to the end of time. Facts in Nature will always bear repeating, and as it may be laid down as a maxim that no injurious insect can be successfully combated without a thorough knowledge of its habits and transformations, I will first recount those of the Canker-worm, and afterwards state the proper remedy.

The eggs of this insect are very minute, measuring about 0.03 inch in length and 0.02 in diameter. In form they are not unlike a miniature hen's egg, minutely roughened and with longitudinal irregular depressions. They reflect prismatic colors, and are deposited close together in rows, forming batches such as that shown in the above Figure 66, *a* representing them of the natural size, and *b* representing them magnified. They are glued together by a grayish varnish which the mother moth secretes, and they are attached to the trunk, or to some one or other of the twigs of the tree, and may often be found on the inside of loose scales of bark, each batch consisting of upwards of a hundred eggs.

As the leaves begin to form, these eggs hatch into minute, thread-like span-worms, which in from three to four weeks afterwards acquire their full size, when they appear as at Figure 66 *c*. The Canker-worm is distinguished from most other caterpillars that attack the Apple, by having but four prolegs at the end of the body. The normal number of such prolegs in caterpillars, is ten; and it is the lack of the foremost six which obliges our insect to span or loop, from which habit the characteristic name GEOMETRIDÆ has been given to the group to which it belongs.

When full-grown this worm measures scarcely an inch in length, and is commonly ash-gray on the back, darker at the side and yellowish

[Fig. 67.]

beneath. It varies greatly in the intensity of its markings however, ash-gray, green, and yellow ones occurring in the same brood, and the most constant character by which it may be distinguished from other span-worms of the same size, is the pattern of the head, which, no matter what the general hue of the body may be, is usually shaded and marked as in the annexed Figure 67. The markings of the worm vary indeed so much, that, without this criterion I could hardly venture to determine a Canker-worm larva myself.

I subjoin a very full description of this worm from numerous average specimens, as it is of considerable importance, that an orchardist may be able to ascertain definitely whether he is troubled with the true Canker-worm or not. For if he mistakes some other span-worm which produces winged females as well as winged males, for the genuine Canker-worm which is apterous in the female moth state, it becomes very obvious that all his efforts to try and prevent the ravages of the spurious Canker-worm by the most approved and well-tried methods, will not only fail most absolutely, but he will lose all faith in such remedies, and may perchance, if he is given to the use of the quill, vent his wrath and disappointment by sending to some one of the horticultural journals of the land, a pithy article "based upon FACTS [?] and EXPERIENCE" showing up the utter worthlessness of the Canker-worm remedies!

It is from such lack of true knowledge that the City Fathers of Baltimore, Maryland, went to the useless expense of furnishing oil troughs for all their large elm trees which were being defoliated, under the delusive idea that the insect committing the ravage was the Canker-worm; whereas it turned out to be the larva of a little imported Beetle (*Galeruca calmariensis*, Fabr.), the female of which has ample wings, and can fly as readily as a bird from tree to tree; and it is from such oversights, that paragraphs like the following take their rise. This one may be found in the *Boston Journal* for may 23d, 1866:

ORIGIN OF CANKER-WORMS.—A Medford correspondent says that last fall he applied to his trees protectors which were pronounced the best in the neighborhood, and notwithstanding not a single grub passed over them, the trees, like others in the vicinity, are this season covered with worms which are now pursuing their devastating work. In his opinion the Canker-worms do not originate from the grub, and he challenges proof that they do. The subject is one worthy of investigation!

Whe-e-e-e-ou! It needs no comments in this Report.

When first hatched the young Canker-worms are of a dark olive-green or brown hue, with a shiny black head and thoracic legs, with a whitish lateral and dorsal band, the latter having a darker central line along it. After the first moult, the head becomes lighter and mottled, and the light bands less conspicuous. After the second moult the bands are almost obliterated and the body becomes more uniformly mottled and speckled with livid-brown; the head becomes still lighter and the prolegs being now large, spread out at almost a level with the venter. After the third (and I believe last) moult the appearance changes but little. The full grown larva averages 0.90 inch in length with an average diameter of 0.10 inch, being broadest on joint 11. It varies from light fleshy-gray to almost black. Head mottled as in Figure 67. Ends of body somewhat darker than middle. Joint 1 with a yellowish dorsal shield, the hinder margin in form of a rounded W. Viewed under a lens the body has a series of eight fine light yellowish, irregular, somewhat broken lines, running the whole length of the body, each one relieved by a darker shado each side of it. The two along middle of dorsum are close together, with the space between them usually dark, and occupied at anterior edge and middle of joints 5, 6, 7 and 11 by black marks somewhat in form of x, these marks being represented by simple black dots on the other joints. Space between these dorsal lines and the next lowest, lighter, and containing four black piliferous spots to each joint, the posterior ones rather further apart than the anterior ones which on joint 11 form two larger elevated shiny black spots. Space between lines 2 and 3 darker than any other part of the body. That between lines 3 and 4 lighter than any other part of body and containing the stigmata which are perfectly round and black with a light centre, with a small piliferous spot anteriorly above and below them, and another behind them, this last becoming large on joints 5, 6, 7 and 8. Venter dark and livid at borders, with a pale greenish band along the middle, which has a pinkish patch in it on joints 5, 6, 7 and 8. Legs greenish at base, color of body at extremity. The markings are most distinct on the light specimens.

The Canker-worm is by no means confined, in its destructive work, to the Apple, for it likewise attacks the Plum, the Cherry, the Elm, and a variety of other trees. Mr. R. J. Mendenhall, of Minneapolis, Minn., even informs me, in a recent letter, that "the Currant worm" spoken of in a late number of the *Farmer's Union* as infesting the currant bushes in the gardens around that city, were really Canker-worms, but he is most assuredly mistaken. The Canker-worm is seldom ever noticed on our trees till the riddled and seared appearance of the foliage tell of its presence; for, like most other spanworms, it has the habit of resting in a stiff straight posture, either at an angle of about 45° from, or flat and parallel with the twig which it occupies—thus eluding detection.

After it has attained its full size it either crawls down the tree or lets itself down by means of a silken thread, and burrows into the ground. Here, at a depth of two or three inches, it forms a rude cocoon of particles of earth intermixed with silk (Fig. 66, *d*). Within two days after completing the cocoon the worm becomes a chrysalis of a light brown color. The sexes are now distinguishable, the male chrysalis (Fig. 66, *e*) being slender, pointed in front, and showing the wing-sheaths; while that of the female is larger and destitute of wing-sheaths.

In the latitude of St. Louis, the worms have generally descended from the trees and entered the ground by the middle of May, though some remain till about the first of June. As I have amply proved during the past two summers, there is but one brood each year in this State, just as there is but one brood in Maine, and whether the worms enter the ground the first or the last of May, they remain there as chrysalids all through the summer and fall months, and the great majority of them till the following spring. A frost seems to be necessary to their proper development. Some come out during the first mild weather that succeeds the first frosts in November; others issue all through the winter whenever the ground is thawed, and the great bulk issue as soon as the frost is entirely out of the ground in spring. Many which I bred this winter issued during the warm weather of January.

The moths (Fig. 66 *f* ♂, *g* ♀) show great disparity of sex, the male being fully winged while the female is entirely destitute of these appendages. The front wings of the male are pale ash-gray, crossed by three equidistant jagged, more or less defined, black lines, all curved inwardly, and most distinct on the front or costal border; and by a somewhat broader whitish line, which runs from the posterior angle to the apex; the inner and terminal borders also being marked with black. The hind wings are silvery-gray, and the under surfaces are of the same uniform silvery-gray color, each wing with a dusky discal spot, the front wings each with an additional spot on the costa. Such is the appearance of the more common perfect specimens found in the West, but the wings are very thin and silky, and the scales easily rub off, so that it is almost impossible to capture a perfect specimen at large. They vary considerably also—so much so that Dr. Harris ranks a smaller form as a distinct species (*A. pometaria*) which I have however bred promiscuously with the more typical specimens. The most common variation from the brief description above given, is found in such specimens which have the dark lines obsolete, and an additional white line inside the one described. The female is ash-gray, the thorax with a black spot, the body more or less marked with black along the back, and the legs alternately marked with black and white.

In Missouri the Canker-worm is not so injurious over broad tracts of country, as it is in some of the more eastern States. Yet it is sufficiently distributed in different parts, to require vigilance to keep it down. "R. P.," of Mexico, Mo., found it very injurious in the spring of 1868, and sent me many specimens, and they were the genuine article. Around Pevely, I have likewise found it common on the farms of Dr. Varnum and Mr. Foster. Mr. Wm. M. Beal of Edina tells me that it is considered one of the very worst enemies in Knox county, and as I am informed by Mr. J. D. Dopf, editor of the *Journal*, Rockport, Atchison Co., it was exceedingly troublesome to the elms there in 1866. Where they have once become established, and are neglected, their ravages soon become very great; and they were so bad in certain parts of Michigan a few years ago, and especially in the Grand Traverse region in 1865, that, unless my memory fails me. a certain Eastern editor, in response to an appeal for a remedy from Mr. Sanford Howard, the Secretary of the Michigan State Board of Agriculture very foolishly urged the Wolverines to cut down their trees. May I hope that these Entomological Reports will be the means of protecting Missouri from the fearful ravages of this worm which has so often discouraged the orchardists in Massachusetts, Rhode Island, Connecticut, and some of the Middle States.

It is the apterous condition of the female moth which gives us such complete control of this enemy, and which indicates

THE PROPER REMEDY.

The sole object of the female, after she leaves the earth, seems to be to provide for the continuance of her kind, and she instinctively places the precious burden, which is to give birth to the young which she herself is destined never to behold, upon the tree whose leaves are to nourish those young. All her life-energy is centered in the accomplishment of this one object, and she immediately makes for the tree upon issuing from the ground. Consequently, anything that will prevent her ascending the trunk will, in a great measure (but as we shall presently see, not entirely) preserve the tree from the ravages of the worm.

Numerous indeed have been the devices—patented or unpatented—which have at different times and in different parts of the country been used to accomplish this desired end; and every year our Agricultural journals report individual experiments with some one or other of these devices—some favorable and others adverse. Tar, applied either directly around the body of the tree, or on strips of old canvas, on sheep-skin, or on stiff paper; refuse sorghum molasses, printers' ink, or slow-drying varnishes. or melted India rubber, which always retains its soft viscid state, applied in a similar manner; tin, lead, and rubber troughs to contain oil; belts of cotton-wool, etc., etc., have all been used, and with both good and bad results, very much according as they have been used intelligently or otherwise. Now, all these appliances, of whatsoever character, are divisible into two classes: first, those which prevent the ascension of the moth by entangling her feet, and trapping her fast, or by drowning her; and, second, those which accomplish the same end by preventing her from getting a foothold, and thus causing her repeatedly to fall to the ground until she becomes exhausted and dies.

The first class of remedies are thoroughly effectual when applied understandingly and persistently. And by this I mean, that the orchardist must know that many of the moths issue in the fall of the year, and that the applications must, in consequence, be made at least as early as the latter part of October, and that they must be kept sticky, through all but freezing weather, till the leaves have well put out, in the following spring. Furthermore he must know that many of the moths—frustrated in their efforts to climb the tree—will deposit their eggs near the ground or anywhere below the application, and that the young worms hatching from them are able to pass behind the slighest crevice or over the finest straw. Thus, if troughs are used, they must be fitted over a bandage of cotton-wool, so that when the trough is drawn tightly around the tree, it will do no injury, and will at the same time cause the cotton to fill up all inequalities of the bark; the joint must likewise be kept smeared either with tar or molasses, and then the worms will not be able to pass. In the neglect to thus fasten them, lies the secret of failure which many report who use such troughs. The second class of contrivances are of no avail whatever, for although the moth is unable to travel over a very smooth surface, I know from experience that the young worms can march over the smoothest glass by aid of the glutinous silken thread which they are able to spin from the very moment they are born. For these reasons, even the "Merritt's Patent Tree-Protector," which was so well advertised by Mr. Howard in his otherwise excellent article on the Canker-worm, in the Michigan Agricultural Report for 1865, must be classed with the worthless patents. This "Protector" consists of a ring of glass grooved below and hung from the tree by a tent of canvas, to which it is fastened by an iron clamp.

I might enumerate a number of such ingenious contrivances both of glass, wood, tin, and isinglass, for heading off the female moth *only*, and some few which are sufficiently thorough to head off the young larvæ also; but they are all so expensive, that I am perfectly convinced they will never be adopted in our large orchards; nor are they necessary, for some of the remedies already mentioned are altogether more simple and more effectual.

It cannot be denied that it requires a great deal of time, labor and expense to continually renew the applications of tar on every tree in a large orchard during so many months of the year; while its application directly to the bark is more or less injurious to the trees. For these reasons, refuse sorghum molasses will be found much better for the purpose, as it does not harden so rapidly, and is said not to be injurious to the tree. In neighborhoods where sorghum is grown, it is also much cheaper. That it will pay to do this work in orchards where the Canker-worm is known to be numerous, there cannot be the least doubt. The old adage, "What is worth doing at all is worth doing well," was never truer than in fighting this insect, Apply the remedy thoroughly during two successive years, and you have utterly routed the enemy, and this is more especially the case where an orchard is not in too close proximity to the timber, or to slovenly neighbors. Fail to apply the remedy, and the enemy will, in all probability, rout you. The reason is simple. The female being wingless, the insect is very local in its attacks, sometimes swarming in one orchard and being unknown in another which is but a mile away. Thus, after it is once exterminated, a sudden invasion is not to be expected, as in the case of the Tent Caterpillar, and of many other orchard pests; but when it has once obtained a footing in an orchard, it multiplies the more rapidly, for the very reason that it does not spread fast.

If oil troughs are used, it will be found much safer, and surer to sink them in the ground close around the butt of the tree, instead of winding them around the trunk higher up. There will then be no chance for the young worms to get up between the trough and the tree. But it follows, that this plan can only be adopted in an orchard which is kept perfectly clean.

As for muriate of lime, which has been so earnestly recommended as a preventive, by interested parties, here is what Mr. Sanford Howard says of it in the *Western Rural* of August 18th, 1866, and Mr. Joseph Breck, editor of the old American *Journal of Horticulture*; G. C. Brackett, correspondent of the *Maine Farmer*, and several other persons with whom I am acquainted, all testify, after having thoroughly tried it, to its utter worthlessness for this purpose:

The editor of the *Farmer* says, there are statements to the effect, that a substance called Gould's Muriate of Lime, applied to the soil in autumn, had entirely prevented the subsequent appearance of Canker-worms on trees standing on the ground, although the trees had previously been much damaged by the insect. It is also stated that on other trees, not ten rods distant, where none of the so-called muriate of lime was applied, the worms were very destructive.

I cannot think that this amounts to any proof that the substance applied destroyed the worms, or had any effect on them. The non-appearance of the insect in the case alluded to, was probably due to other causes. If this substance will kill or injure the insect in any of its stages, it would be easy to prove it by a direct application to soil containing insects, in a box. Several years ago, I took pains to make a particular experiment with this so-called muriate of lime, the result of which was that the Canker-worm underwent its transformations naturally, and to all appearance healthfully, in a soil composed of nearly fifty per cent. of the articles of which it was said a small proportion only was necessary to totally destroy them? If the substance is the same in composition now that it was then, it is reasonable to suppose that the result of its application would be the same.

As to the "Plug Ugly Theory," which consists of filling an auger bore with sulphur and plugging it tight, and which originated, some years since, in the inventive brain of some *Prairie Farmer* correspondent; it is altogether too absurd to need consideration, for even if the mode of application were not so downright ridiculous, it is well known to entomologists that many caterpillars will thrive exceedingly on leaves that have been thickly sprinkled with sulphur.

Vigilance is the price of reward, and as it is always easier to prevent than to cure, it were well for the owners of young orchards, in neighborhoods where the Canker-worm is known to exist, to keep a sharp look-out for it; so that upon its first appearance the evil may be nipped in the bud. In the same manner that it is exterminated in the individual orchard, in like manner, it may, by concert of action, be exterminated from any given locality. When once the worms are on a tree, a good jarring will suspend them all in mid-air, when the best way to kill them is by swinging a stick above them, which breaks the web, and causes them to fall to the ground; when they may be prevented from ascending the tree, by the methods already described, or by strewing straw on the ground and setting fire to it.

One word in commendation of late fall plowing and the use of hogs. A good deal has been said both for and against fall plowing, and the following discussion which took place at the November (1868) meeting of the Alton (Ills.) Horticultural Society, will afford a sample of the different opinions held by individuals:

Dr. Long took the ground that fall plowing was one of the best and surest means of eradicating those insects which stay in the ground over winter. He said, some five or six years ago my orchard was badly infested with the Canker-worm; by late cultivation, I almost, if not entirely, got rid of them.

Dr. Hull—I do not believe that fall plowing will destroy the larvæ of insects to any extent. I have dug up frozen lumps containing larvæ that were not affected by freezing. I think the Canker-worm will not spread here as in New England.

J. Huggins—I have been led to believe—contrary to Dr. Hull's statement—that they will spread, and feel that there is great danger of their spreading. I believe fall plowing a great aid in the extermination of them. Cites a case where they have been almost entirely destroyed by late plowing, in an orchard that was nearly ruined by them.

Dr. Hull—If it be true that they will spread, why is it that none of Dr. Long's neighbors have them? He says he was badly overrun with them, and the fact that his neighbors were not, I think confirmation of my statement that they will not spread.

Dr. Long—My brother's orchard, adjoining mine, had double as many as my own. He fall plowed, and has very few left. He also cites the case of an old orchard, in this section, that was almost destroyed by them, but fall plowing has almost, if not entirely, destroyed them.

The following item from the New York Weekly *Tribune* of February 26th, 1869, also bears on this point:

Canker-worms Destroyed by Plowing.—Mr. McNeil Witherton, in answer to W. V. Monroe's request: I will state that I think that the Canker-worm can be destroyed by plowing the ground where they are, late in the fall. The 25th of Nov., 1867, I was at my son David's in Wisconsin. He told me that the Canker-worms were in his orchard, and had injured his apple trees very much the past season; that a man who owns a nursery and keeps apple trees for sale, went into the orchard and examined the trees and worms, and said it was the Canker-worm that was injuring his orchard. I told him that about fifty years ago they had been in my father's orchard some six years, and killed a large number of the trees; that we plowed it late in the fall, and have never seen the Canker-worm there since. I advised him to plow his orchard immediately. The next day he plowed it as far as the worms had been in it. I received a letter from him a few weeks ago, stating that the Canker-worms were not in his orchard this year, and those trees that were injured and not killed last year, revived some this year.

Now there is no doubt but late plowing will produce somewhat different effects, according to the character of the soil, and the depth of the plowing; but that it is more generally beneficial than otherwise I am perfectly convinced, and as for the assertion of Mr. Wm. P. Lippincott, of Vernon, Iowa, made some time ago, in the *Iowa Homestead*, namely, that it left the ground full of harbors for the next year's breeding, it suffices to say that the insect does not breed in the ground, and, holes or no holes, the worms will penetrate the soil whenever the time arrives to change to chrysalis. After the summer months the insect invariably lies in the chrysalis state snugly entombed in a little earthen cell very thinly lined with silk, from two to six inches below the surface. This cell, though frail, is a sufficient protection, so long as it is whole, from any excess of moisture, and at the same time prevents too much evaporation in case of summer drouth or dry winter freezing. Now I have proved by experiment that whenever this cell is disturbed or broken in cold weather, the chrysalis has not the power to penetrate the ground again, and in the great majority of instances, either rots, dries out, becomes mouldy, or, if on the surface, is devoured by birds. Even summer plowing, if performed after the first of July would work beneficially; and it is for this reason, that clean, well cultivated orchards are more free from the attacks of this insect, than slovenly and neglected ones. The only advantage of late fall plowing, lies in the facts, that the chrysalis is at that time too benumbed to work itself into the ground and form another cell, and that birds are then harder pushed for food, and more watchful for any such dainty morceau.

As to the efficiency of hogs, in rooting up and devouring the chrysalids, during the summer months, abundant favorable testimony might be cited; but the facts are too obvious to need argument.

ENEMIES OF THE CANKER-WORM.

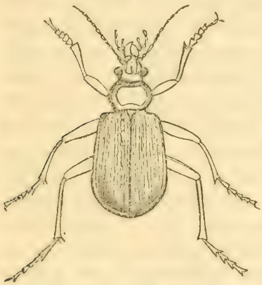
Like most of our noxious insects, the Canker-worm is subject to the attacks of cannibal and parasitic insects. It is also devoured by very many different birds, some of which almost entirely live on it; and Dr. Packard, of Salem, Mass., has observed an elongated mite (*Nothrus ovivorus*, Fig. 68, enlarged) devouring its eggs. The most common parasite which I have yet discovered with us, is an undescribed small four-winged fly belonging to the genus *Microgaster*, of the same size, but differing from the Military Micro-

[Fig. 68.]

gaster (Fig. 23) which preys upon the Army-worm. It differs also from most other insects of the same genus, by each individual larva as it eats through the skin of the Canker-worm, spinning its pale greenish-white cocoon alone, and not in company. About ten per cent. of the worms which I have endeavored to breed, have been destroyed by this parasite. Harris mentions the larva of another four-winged fly, and that of a two-winged fly belonging to the genus *Tachina*, which also infest the worm, destroying about one-third of them in Massachusetts. There is also a very minute and undescribed species of *Platygaster* which pierces the egg of the Canker-worm, and drops one of her own into it, from which in due time the perfect fly develops.

Among the Cannibal insects, which prey upon it, may be mentioned the Ground-beetles, two of which I have found preying upon this worm, namely, the Rummaging Ground-beetle (*Calosoma scrutator*, Fabr. Fig. 69), a large and beautiful insect, with the wing-covers golden-green, and the rest of the body marked with violet-blue, gold, green, and copper; and the Fiery Ground-beetle (*Calosoma calidum*, Fabr. Fig. 70.), a black species of almost equal size, with copper colored spots on the wing-covers. These beetles are very active, and run over the ground in search of soft-bodied worms, and will even mount upon the trunks of trees for the same purpose.

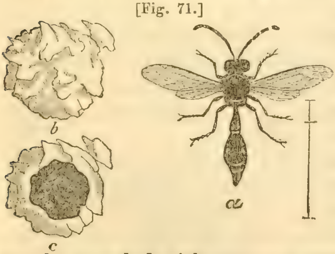
[Fig. 69.]



[Fig. 70.]

The Fraternal Potter-wasp (*Eumenes fraterna*, Say), is stated by Harris, to store her cells with Canker-worms, often gathering eighteen or twenty of them for a single cell. This wasp (Fig. 71, *a*), is quite common in St. Louis county, and uses other species besides Canker-worms as food for its young. Its clay nest (Fig. 71 *b*, entire; *c*, the same cut open shortly after it was built, showing the manner in which it is compactly crowded with green worms), may often be found attached to the stems of the Goldenrod and of other plants in the open air, or cemented under the loose bark of some tree. It has even been found attached to the leaves of a deciduous plant, where it must necessarily fall to the ground in winter and lie there till the perfect insect issues in the following summer.

[Fig. 71.]



CABBAGE WORMS.

Of the various insects that affect this important esculent, the three following are among the most injurious in this State:

THE SOUTHERN CABBAGE BUTTERFLY—*Pieris protodice*, Boisd.

(Lepidoptera, Pieridæ.)

Mr. S. H. Scudder, of the Boston Society of Natural History, from an examination of a large number of specimens of this butterfly, found that it enjoys a wide geographical range, "extending from Texas on the southwest, Missouri on the west, and the mouth of the Red River of the North on the northwest, as far as Connecticut, and the Southern Alantic States on the east."* But while the species is scarce in the more northern States, it is the common white butterfly of Missouri, abounding in many parts of the State, and sometimes flitting so thickly around the truck gardens near large cities, as to remind one at a distance, of the falling of snow. It often proves exceedingly injurious, and I learn from a Mississippi exchange, that "there were last year thousands of dollars' worth of cabbages devastated and ruined by worms in the neighborhood of Corinth." The paragraph goes on to state, "that cabbages could not, in consequence, be had there even at ten cents per head." The "worm" referred to, was doubtless the species under consideration.

[Fig. 72.]

[Fig. 73.]

I have often passed through cabbage beds near St. Louis, and been unable to find a perfect head, though few of the gardeners had any suspicion that the gay butterflies which flitted so lazily from one plant to another, were the real parents of the mischievous worms which so riddled the leaves.

The larva (Fig. 72, *a*) may be summarily described as a soft worm, of a greenish-blue color, with four longitudinal yellow stripes, and covered with black dots. When newly hatched it is of a uniform orange color with a black head, but it becomes dull brown before the first moult, though the longitudinal stripes and black spots are only visible after said moult has taken place.

I subjoin a more complete description of it:

Average length when full grown 1.15 inches. Middle segments largest. Most common ground-color green verging onto blue; sometimes clear pale blue and at others deep indigo or

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* See Proc. Bost. Soc. Nat. Hist., VIII, 1861, p. 180.

purplish-blue. Each segment with six transverse wrinkles, of which the first and fourth are somewhat wider than the others. Four longitudinal yellow lines, each equidistant from the other, and each interrupted by a pale blue spot on the aforementioned first and fourth transverse wrinkles. Traces of two additional longitudinal lines below, one on each side immediately above prolegs. On each transverse wrinkle is a row of various sized, round, polished black, slightly raised, piliferous spots ; those on wrinkles one and four being largest and most regularly situated. Hairs arising from these spots, stiff and black. Venter rather lighter than ground-color above, and minutely speckled more or less with dull black. Head same color as body ; covered with black piliferous spots, and usually with a yellow or orange patch each side—quite variable. The black piliferous spots frequently have a pale blue annulation around the base, especially in the darker specimens.

The chrysalis (Fig. 72, *b*), averages 0.65 inch in length, and is as variable in depth of ground-color, as the larva. The general color is light bluish-gray, more or less intensely speckled with black, with the ridges and prominences edged with buff or with flesh-color, and having larger black dots.

[Fig. 74.]

The female butterfly (Fig. 73) differs remarkably from the male which I represent at Figure 74. It will be seen, upon comparing these figures that the ♀ is altogether darker than the ♂. This sexual difference in appearance is purely colorational, however, and there should not be the difference in the form of the wings which the two figures would indicate, for the hind wings in the ♂ cut, are altogether too short and rounded.

This insect may be found in all its different stages through the months of July, August and September. It hybernates in the chrysalis state. I do not know that it feeds on anything but Cabbage, but I once found a ♂ chrysalis fastened to a stalk of the common nettle (*Solanum carolinense*), which was growing in a cemetery with no cabbages within at least a quarter of a mile : and Mr. J. R. Muhleman is reported as having stated at a late meeting of the Alton (Illinois) Horticultural Society, that it is injurious to turnips and other plants of the cabbage family. There are two broods of this insect each year.

As already stated, in the more northern and eastern States our Southern Cabbage Butterfly occurs in comparatively small numbers, but it is replaced by the Potherb Butterfly (*Pieris oleracea*, Boisd.), an indigenous species which does not occur with us. This last (Fig. 75, butterfly with the larva beneath) is in reality a northern species, for it rarely reaches as far south as Pennsylvania, but extends east to Nova Scotia, west to Lake Superior, and north as far as the Great Slave Lake in the Hudson's Bay Company's territory. It is readily distinguished

[Fig. 75

from our species by being perfectly plain, with no black spots on the wings. The body is black, and the front wings have a slight shade of this color at their base, front edge, and tips. Its larva is pale green and feeds on various other cruciferous plants besides cabbages; its chryalis (Fig. 76) is also pale green or whitish, regularly and finely dotted with black.

[Fig. 76.]

This butterfly has existed from time immemorial on the American continent, within the geographical limits already given, and yet has never made its way into Missouri or any of the southwestern States. Nor is it likely to ever do so; and why? Because some insects are constitutionally incapacitated to live beyond certain geographical limits. The range of an insect is governed by various influences which I have not time to enumerate at present; but the principal influence is undoubtedly climate—temperature—heat. The "isothermal" lines, or the lines of equal heat, as all physical geographers are well aware, do not run parallel with the lines of latitude, as one might at first thought suppose; but if our isothermal maps are to be relied on, vary most astonishingly to points north and south of a given line. The same variation from a given line of latitude is noticeable in the distribution of insects, or—to coin a word—we have "isentomic," or iso-insect lines, which are as variable as the lines of equal heat, by which they are doubtless to a great extent governed. In Central Missouri we live on nearly the same latitude as that of Southern Pennsylvania, and in North Missouri, as that of Southern New York; yet we do not live on the same insect line, but nearly on that of Virginia and North Carolina, and even in the extreme northern part of the State, a number of insects are found, which on the Atlantic seaboard are never known to occur north of Virginia, and the same rule holds good with the birds and fishes of the United States. The same thing is true of our Central and Southern counties. In other words many of our insects are *southern*, not *northern* species, and as familiar examples, I might mention the Tarantula of Texas (*Mygale Hentzii*, Girard), and its large Digger-wasp enemy (*Pepsis formosa*, Say), which have been frequently found in St. Louis county during the past two years, though they were for a long time supposed to be confined to Texas.

Now, since the indigenous Potherb Butterfly has never, in the course of past ages, extended to any point South of Pennsylvania, although its cruciferous food-plants have always flourished South of that line, we are justified in concluding that it never will do so, and that though a brood of the worms were introduced directly on to some cabbage patch in the extreme Northern part of this State, they would soon die out there.

Consequently we have nothing to fear from this butterfly which has always troubled our northeastern friends. But the case is very different with another white cabbage butterfly which is now committing sad havoc to the cabbages in some parts of Canada, and some of the Eastern States. The species I refer to is the Rape Butterfly (*Pieris rapæ*, Schrank), a recent importation from Europe, and while I have no fear of any evil results arising from the introduction of the Potherb Butterfly, I should hate to try the experiment of introducing a brood of worms of the Rape Butterfly into any portion of the State; because, for the reasons detailed in the paper read before the State Horticultural Society, and which is published at the beginning of this Report, I have not a doubt but they would flourish exceedingly, and become far more injurious than either of the indigenous species. Indeed, the history of this insect, since its introduction into this country, affords sufficient proof that such would be the result, for M. Provancher in a recent number of his journal, *Le Naturalista Canadien*, says that it alone, has caused more damage around Quebec, since its arrival there, than all other noxious butterflies put together, in the same space of time; and he estimates that it annually destroys $240,000 worth of cabbages around that town. In short, as this insect is rapidly spreading westward, there is every reason to fear that it may some day get a foothold in our midst, unless the proper measures are taken to prevent such an undesirable occurrence. It will be well therefore to familiarize the reader with its appearance, for "to be forewarned is to be forearmed!"

Little did I dream, when, many years ago, I watched this butterfly fluttering slowly along some green lane or over some cabbage patch in England, where it is THE butterfly; or when I found its chrysalis so abundantly in the winter time on old palings or even on the kitchen wall indoors—that I should some day be fearing its presence here. But just as little did our forefathers dream of the immense though gradual changes which have come over this broad land during the last two or three centuries! Coming events are said to cast their shadows before them, but verily we know not what the morrow will bring forth.

This Rape Butterfly is the bane of every cabbage grower, and its larva is the dread of every cook in many parts of Europe. Unlike the two indigenous N. A. species already alluded to, this worm is not content with riddling the outside leaves, but prefers to secrete itself in the heart, so that every cabbage has to be torn apart and examined before being cooked, and it is also necessary to keep a continual lookout, even after it is dished up, lest one gets such an admixture of animal and vegetable food as is not deemed palatable by the most of men. It is on account of this habit of boring into the heart of cabbages, that the French call it the "Ver du Cœur" or Heart-worm.

It was introduced about 1856 or 1857, having been first taken in Quebec in 1859. In 1864 Mr. G. J. Bowles, who published an account of it in the *Canadian Naturalist and Geologist*, for August, 1864, p. 258, estimated that it had not then extended more than forty miles from Quebec as a centre. In 1866 it was taken in the northern parts of New Hampshire and Vermont; in 1868 it had advanced as far

South as Lake Winnepesaugee. It having since been taken at Bangor, and at other points in Maine; in certain parts of New Jersey, and the past year around Boston and New York.

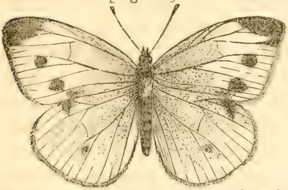
It was in all probability introduced into this country in the egg state, for the eggs are deposited on the underside of the leaves, and there is nothing more likely than that a batch may have been thrown with refuse leaves from some vessel, and that after hatching the young larvæ managed to find suitable food close by.

[Fig. 77.]

The larva (Fig. 77, *a*), is pale green, finely dotted with black, with a yellowish stripe down the back, and a row of yellow spots along each side in a line with the breathing holes. When about to transform, it leaves the plant upon which it fed, and shelters under the coping of some wall or fence, or on anything that may be conveniently at hand, and changes to a chrysalis (Fig. 76, *b*) which though variable in color, is usually pale green, speckled with minute black dots. The insect passes the winter in this state and as with the two indigenous species, there are two broods each year.

The butterflies have the bodies black above, with the wings white, and marked as in the accompanying cuts; the female (Fig. 78) being distinguished from the male (Fig. 79) by having two round spots (sometimes three) instead of only one on the front wings. Underneath, both sexes are alike, there being two spots on the front wings and none on the hind ones, which are yellowish, sometimes passing into green. The species varies very much, and there is a specimen in my collection in which all the spots are so nearly obsolete above, that if it were not for the characteristic under-surfaces, it could scarcely be distinguished from the Potherb Butterfly. There is also in England a variety of the male sex which has the ground-color canary yellow instead of white, and curiously enough, this same variety has been taken in this country.

[Fig. 78]

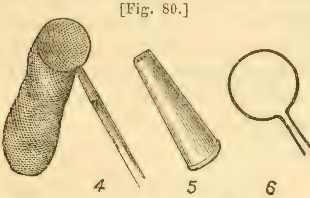


[Fig. 79.]

Although some caterpillars are polyphagous, feeding indiscriminately on a great variety of plants, yet most of them are confined to plants of the same botanical family, or at all events of the same natural order. Such is the case with the two indigenous cabbage butterflies above mentioned, for they are not known to go beyond cruciferous plants for food. The Rape Butterfly has a less epicurean palate however, and departs from this rule, inasmuch as it has been known to feed upon the weeping willow in England.

Remedies.—One way of counterworking the evil effects of these cabbage butterflies, is to search for the eggs at the proper season, and destroy them. These eggs are pear-shaped, yellowish and longitudinally ribbed, but as they are deposited singly or in clusters of not more than two or three, the operation becomes tedious and somewhat impracticable on a large scale. Still, children should be taught how to find them, and incited to search for them by the hope of a reward for a certain number. The butterflies are slow lumbering flyers and may easily be caught in a net and killed. A short handle, perhaps four feet long, with a wire hoop and bag-net of muslin or musquito netting, are the only things needed to make such a net, the total cost of which need not be more than fifty or seventy-five cents. Or a more durable one may be made, in the following manner: Get a tinsmith to make a hollow handle of brass or tin from six to seven inches in length and tapering at one end, as seen in Figure 80, 5; then procure a piece of stout wire, rather more than a yard long, and bend it in the manner shown in Figure 80, 6. Place the ends of the wire in the small end of the handle, solder it on, and then fill in one-third of the handle with molten lead, so as to make the wire doubly fast and solid. Now make a bag of some strong but light fabric, and fasten it well to the wire. The depth of the bag should be more than twice the diameter of the wire hoop. If a handle is required, a wooden one is easily made to fit into the hollow brass or tin, as at Figure 80, 4. Poultry, if allowed free range in the cabbage field, will soon clear off the worms of our indigenous species.

[Fig. 80.]



By laying pieces of board between the cabbage rows, and supporting them about two inches above the surface of the ground, the worms will resort to them to undergo their transformations, and may then be easily destroyed.

Either Paris green or white hellebore will kill the worms, if sprinkled on to them, but cannot be used on cabbages, as it is difficult to free the plants of these substances which are poisonous. The saponaceous compounds of cresylic acid are effectual, and without these objections.

In Europe there are many parasites which serve to check the increase of the Rape Butterfly, and Curtis enumerates at least four. But on this continent, but one such parasite has so far been found to attack it, and that was a two-winged fly—probably a *Tachina* fly—which M. Provancher bred from the chrysalis, in Quebec, Can.* M. Provancher, after remarking that he found a chrysalis which, from its blacken-

*(*Naturaliste Canadien* Vol. II, p. 18.)

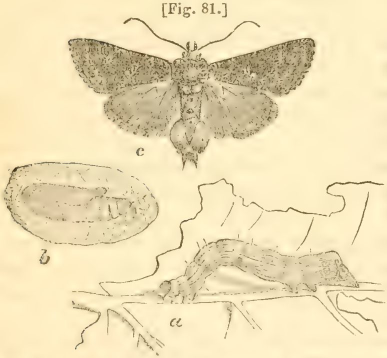
ing in the middle, he suspected would not develop into a butterfly, says of this parasite that he afterwards found a cocoon [pupa?] by its side which was smooth blackish and oblong, and so large that he could scarcely believe it had escaped from the chrysalis, which was, however, now pierced in the middle and empty. M. Provancher goes on to say: "Ten days afterwards, we perceived one morning that the cocoon was open at one end, and there was buzzing about in the vial a fly, which we recognized as belonging to the genus *Sarcophaga* [flesh-flies], the larvæ of which are known to develop in meat. Here then, we exclaimed, when we saw this fly, is an enemy of the Rape Butterfly. But unfortunately the flesh-flies feed indiscriminately on almost any kind of flesh, and never being very numerous, cannot become very redoubtable enemies of this butterfly."

With all due respect to my friend Provancher, I incline to believe that he has mistaken a *Tachina* fly which is a true parasite, for a flesh-fly (*Sarcophaga*) which is only a scavenger. And if this be so, his reasoning falls to the ground, for, as we may see in the Army-worm article in this Report, there are no more efficient checks to the increase of injurious insects than these same *Tachina* flies.

THE CABBAGE PLUSIA—*Plusia brassicæ*, N. Sp.

(Lepidoptera, Plusidæ.)

[Fig. 81.]



This is the next most common insect which attacks the Cabbage with us, and curiously enough it has never yet been described. It is a moth, and not a butterfly, and flies by night instead of by day. In the months of August and September the larva (Fig. 81, *a*) may be found quite abundant on this plant, gnawing large, irregular holes in the leaves. It is a pale green translucent worm, marked longitudinally with still paler more opaque lines, and like all the known larvæ of the family to which it belongs, it has but two pair of abdominal prolegs, the two anterior segments which are usually furnished with such legs in ordinary caterpillars, not having the slightest trace of any. Consequently they have to loop the body in marching, as represented in the figure, and are true "Span-worms." Their bodies are very soft and tender, and as they live exposed on the outside of the plants, and often rest motionless, with the body arched, for hours at a time, they are espied and devoured by many of their enemies, such as birds, toads, etc. They are also subject to the attacks of at least two parasites and die very often from disease, especially in wet weather:

so that they are never likely to increase quite as badly as the butterflies just now described.

When full grown this worm weaves a very thin loose white cocoon, sometimes between the leaves of the plant on which it fed, but more often in some more sheltered situation; and changes to a chrysalis (Fig. 81, *b*) which varies from pale yellowish-green to brown, and has a considerable protruberance at the end of the wing and leg cases, caused by the long proboscis of the enclosed moth being bent back at that point. This chrysalis is soft, the skin being very thin, and it is furnished at the extremity with an obtuse roughened projection which emits two converging points, and several short curled bristles, by the aid of which it is enabled to cling to its cocoon.

The moth is of a dark smoky-gray inclining to brown, variegated with light grayish-brown, and marked in the middle of each front wing with a small oval spot and a somewhat U-shaped silvery white mark, as in the figure. The male (Fig. 81, *c*) is easily distinguished from the female by a large tuft of golden hairs covering a few black ones, which springs from each side of his abdomen towards the tip.

The suggestions given for destroying the larvæ of the Cabbage Butterflies, apply equally well to those of this Cabbage Plusia, and drenchings with a cresylic wash will be found even more effectual, as the worms drop to the ground with the slightest jar.

PLUSIA BRASSICÆ, N. Sp.—*Larva*—Pale yellowish translucent green, the dorsum made lighter and less translucent by longitudinal opaque lines of a whitish-green; these consist each side, of a rather dark vesicular dorsal line, and of two very fine light lines, with an intermediate broad one. Tapers gradually from segments 1–10, descending abruptly from 11 to extremity. Piliferous spots white, giving rise to hairs, sometimes black, sometimes light colored; and laterally a few scattering white specks in addition to these spots. A rather indistinct narrow, pale stigmatal line, with a darker shade above it. Head and legs translucent yellowish-green, the head having five minute black eyelets each side, which are not readily noticed with the naked eye. Some specimens are of a beautiful emerald-green, and lack entirely the pale longitudinal lines. Described from numerous specimens.

Crysalis—Of the normal *Plusia*-form, and varying from yellowish-green to brown.

Moth—*Front wings* dark gray inclining to brown, the basal half line, transverse anterior, transverse posterior, and subterminal lines pale yellow inclining to fulvous, irregularly undulate, and relieved more or less by deep brown margins; the undulations of the subterminal line more acuminate than in the others, and forming some dark sagittate points; the basal half-line, the transverse anterior near costa, and the transverse posterior its whole length, being sometimes obscurely double: four distinct equidistant costal spots on the terminal half of wing, the third from apex formed by the termination of the transverse posterior; posterior border undulate with a dark brown line which is sometimes marked with pale crescents; a series of similar crescents (often mere dots) just inside the terminal space; the small sub-cellulary silver spot oval, sometimes uniformly silvery-white but more often with a fulvous centre, sometimes free from, but more often attached to the larger one which has the shape of a constricted U, very generally with a fulvous mark inside, which extends basally to the transverse anterior at costa. Fringes dentate, of the color of the wing, and with a single undulating line parallel to that on the terminal border. *Hind wings* fuliginous, inclining to yellowish towards base, and with but a slight pearly lustre; fringes very pale with a darker inner line. Under surfaces pale fuliginous with a pearly lustre, the front wings with a distinct fulvous mark under the sub-cellulary spots, speckled more or less with the same color around the borders of the wing, the fringes being dentate with light and dark; the hind wings speckled with fulvous on their basal half, and with the fringes as above. *Thorax* variegated with the same color as front wings, the tufts being fulvous inclining to pink. *Abdomen* ♀ gray, with a few pale hairs near the base, and scarcely extending beyond the margin of the hind wings; ♂ longer, covered with pale silky hairs, a distinct dorsal brown tuft on each of the three basal segments, and two large lateral either fawn-colored or golden-yellow brushes on the fifth segment, meeting on the back and partly covering two smaller brushes on the sixth, which are tipped with black; terminal segment flattened and with two lateral more dusky and smaller tufts: underside of thorax and abdomen gray, mixed with flesh-color. Alar expanse 1.55 inches. Described from numerous bred specimens. In a suite of specimens bred from the same brood of larvæ a considerable difference in the general depth of color is found, some being fully as dark again as others.

Closely resembles *Plusia ni*, Engr., which occurs in Italy, Sicily, France, and the northern parts of America. Mr. P. Zeller of Stettin, Prussia, to whom I sent specimens, considers it distinct however from the European *ni*, and I have consequently given it a name in accordance with its habits.

There is another worm which may be known as the Thistle Plusia, and which occurs on our common thistles, and cannot therefore be considered very injurious. It differs only from that of the Cabbage Plusia in having the sides of the head, the thoracic legs, a row of spots above the lateral light line, and a ring around the breathing pores, black. I have bred from it the *Plusia precationis** of Guenée—an insect whose larval history has not hitherto been known.

THE ZEBRA CATERPILLAR—*Mamestra picta*, Harr.

(Lepidoptera, Apamidæ.)

This is another insect which often proves injurious to our cauliflowers and cabbages, though it by no means confines itself to these two vegetables. Early in June the young worms which are first almost black, though they soon become pale and green, may be found in dense clusters on these plants, for they are at that time gregarious. As they grow older they disperse and are not so easily found, and in about four weeks from the time of hatching they come to their full growth. Each worm (Fig. 82. *a*,) then measures about two inches in length, and is velvety-black with a red head, red legs, and with two lateral yellow lines, between which are numerous transverse white, irregular, zebra-like finer lines, which induced Dr. Melsheimer to call this worm the "Zebra." Though it does not conceal itself, it invariably curls up cut-worm fashion, and rolls to the ground when disturbed.

[Fig. 82.]

It changes to chrysalis within a rude cocoon formed just under the surface of the ground, by interweaving a few grains of sand or a

* Some of these bred specimens approach very near to *Pl. iota*, Gn. and even to *Pl. u-brevis*, Gn.

few particles of whatever soil it happens on, with silken threads. The chrysalis is ¾ of an inch in length, deep shiny brown and thickly punctured except on the posterior border of the segments and especially of those three immediately below the wing-sheaths, where it is reddish and not polished; it terminates in a blunt point ornamented with two thorns. The moth (Fig. 82, *b*,) which is called the Painted Mamestra, appears during the latter part of July, and it is a prettily marked species, the front wings being of a beautiful and rich purple-brown, blending with a delicate lighter shade of brown in the middle; the ordinary spots in the middle of the wing, with a third oval spot more or less distinctly marked behind the round one, are edged and traversed by white lines so as to appear like delicate net-work; a transverse zigzag white line, like a sprawling W is also more or less visible near the terminal border, on which border there is a series of white specks; a few white atoms are also sprinkled in other places on the wing. The hind wings are white, faintly edged with brown on the upper and outer borders. The head and thorax are of the same color as the front wings, and the body has a more grayish cast. There are two broods of this insect each year, the second brood of worms appearing in the latitude of St. Louis from the middle of August along into October, and in all probability passing the winter in the chrysalis state, though a few may issue in the fall and hybernate as moths, or may even hybernate as worms; for Mr. J. H. Parsons, of N. Y., found that some of the worms which were on his Ruta Baga leaves, stood a frost hard enough to freeze potatoes in the hill, without being killed.* I have noticed that the spring brood confines itself more especially to young cruciferous plants, such as cabbages, beets, spinach, etc., but have found the fall brood collecting in hundreds on the heads and flower-buds of asters, on the White-berry or Snow-berry (*Symphoricarpus racemosus*); on different kinds of honey-suckle, on mignonette, and on asparagus: they are also said to occur on the flowers of clover, and are quite partial to the common Lamb's-quarter or Goosefoot (*Chenopodium album*).

On account of their gregarious habit when young, they are very easily destroyed at this stage of their growth.

THE TARNISHED PLANT-BUG—*Capsus oblineatus*, Say.†

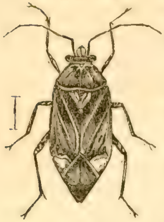
[Heteroptera Capsidæ.]

Quite early last spring while entomologizing in Southern Illinois,

* *Practical Entomologist*, II, p. 21.

† This bug was originally described by Beauvois as *Coreus linearis*, and subsequently as *Capsus oblineatus* by Say. Harris in speaking of it refers it to the sub-genus *Phytocoris* Fallen, and by mistake, changes Beauvois' specific name *linearis*, to *lineolaris*, which he translates into popular language as the "Little-lined Plant-bug." As Say's description is the only one I have access to, I have retained the name he gave it, as being eminently appropriate.

[Fig. 83.]



I spent a day with Mr. E. J. Ayres of Villa Ridge, and was surprised to learn that he had become quite discouraged in his efforts to grow young pear trees, on account of the injuries of a certain bug, which upon examination I found to be the Tarnished Plant-bug, represented enlarged at Figure 83, the hair line at its side showing the natural size. The family to which this bug belongs is the next in a natural arrangement to that which includes the notorious Chinch-bug, and the insect is, like that species, a veritable bug, and obtains its food by *sucking* and not *biting*. The *Capsus* family is a very large one, containing numerous species in this country, but among them, none but the species under consideration have thrust themselves upon public notice by their evil doings.

The Tarnished Plant-bug is a very general feeder, attacking very many kinds of herbaceous plants, such as dahlias, asters, marigolds, balsams, cabbages, potatoes, turnips, etc.; and several trees, such as apple, pear, plum, quince, cherry, etc. Its puncture seems to have a peculiarly poisonous effect, on which account, and from its great numbers, it often proves a really formidable foe. It is especially hard on young pear and quince trees, causing the tender leaves and the young shoots and twigs to turn black, as though they had been burned by fire. On old trees it is not so common, though it frequently congregates on such as are in bearing, and causes the young fruit to wither and drop. I have passed through potato fields along the Iron Mountain Railroad in May, and found almost every stalk blighted and black from the thrusts of its poisonous beak, and it is not at all surprising that this bug was some years ago actually accused of being the cause of the dreaded potato-rot.

This bug is a very variable species, the males being generally much darker than the females. The more common color of the dried cabinet specimens is a dirty yellow, variegated as in the figure with black and dark brown, and one of the most characteristic marks, is a yellow V, sometimes looking more like a Y, or indicated by three simple dots, on the scutel, (the little triangular piece on the middle of the back, behind the thorax). The color of the living specimens is much fresher, and frequently inclines to olive-green. The thorax, which is finely punctured, is always finely bordered and divided down the middle with yellow, and each of the divisions contains two broader logitudinal yellow lines, very frequently obsolete behind. The thighs always have two dark bands or rings near their tips.

As soon as vegetation starts in the spring, the mature bugs which winter over in all manner of sheltered places may be seen collecting on the various plants which have been mentioned. Early in the morning they may be found buried between the expanding leaves, and at this time they are sluggish and may be shaken down and destroyed; but as the sun gets warmer, they become more active, and when approached, dodge from one side of the plant to the other, or else take wing and fly away. They deposit their eggs and breed on the plants, and the young and old bugs together may be noticed through most of the summer months. The young bugs are perfectly green, but in other respects do not differ from their parents except in lacking wings. They hide between the flower-petals, stems and leaves of different plants, and are not easily detected. Late in the fall, none but full grown and winged bugs are to be met with, but whether one or two generations are produced during the season I have not fully ascertained, though in all probability there are two.

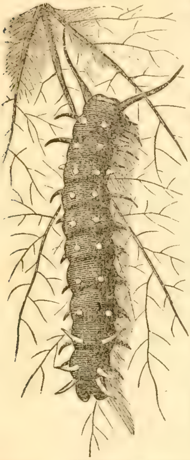
REMEDIES.—In the great majority of cases, we are enabled to counteract the injurious work of noxious insects, the moment we thoroughly comprehend their habits and peculiarities. But there are a few which almost defy our efforts. The Tarnished Plant-bug belongs to this last class, for we are almost powerless before it, from the fact that it breeds and abounds on such a great variety of plants and weeds, and that it flies so readily from one to the other. Its flight is however limited, and there can be no better prophylactic treatment than clean culture; for the principal damage is occasioned by the old bugs when they leave their winter quarters and congregate on the tender buds and leaves of young fruit stock; and the fewer weeds there are to nourish them during the summer and protect them during the winter, the fewer bugs there will be. The small birds must also be encouraged. Applications of air-slacked lime and sulphur, have been recommended to keep them off, but if any application of this kind is used, I incline to think that to be effectual, it must be of a fluid nature; and should recommend strong tobacco-water, quassia-water, vinegar, and cresylic soap. Some persons who have used the last compound have complained that it injures the plants, and every one using it should bear in mind, what was stated in the preface to my First Report, namely, that the pure acid, no matter how much diluted with water, will separate when sprinkled, and burn holes in, and discolor plant texture; while if properly used as a saponaceous wash it will have no such injurious effect. It must likewise be borne in mind, that the so-called "plant-protector" which is a soap made of this same acid, will bear very much diluting, (say one part of the soap to fifty or even one hundred parts of water) and that it will injure tender leaved plants if used too strong. I have noticed that the bugs are extremely fond of congregating upon the bright yellow flowers of the Cabbage, which, as every one knows, blooms very early in the season; and it would be advisable for persons who have been seriously troubled with this bug, and who live in a sufficiently southern latitude where the plant will not winter-kill, to let a patch of cabbages run wild and go to seed in some remote corner of the farm, in order that the bugs may be attracted thither and more readily destroyed, than when scattered over a larger area.

THE PHILENOR SWALLOW-TAIL—*Papilio philenor*, Drury.

(Lepidoptera Papilionidæ.)

There is a genus of climbing plants (the Aristolochias), which is peculiarly attractive on account of its large, rich tropical-looking foliage. The Aristolochias are represented in almost all parts of the world, and some of the tropical species bear beautiful and immense flowers. In this country we have three native species which produce but small, pipe-like flowers, but which make very pretty ornaments for covering walls and arbors or for ornamenting trellises and screens. The most common and best known species in this State is the so called Dutchman's Pipe (*Aristolochia sipho*), but the two other species (*A. serpentaria* and *A. tomentosa*) are also cultivated.

[Fig. 84.]



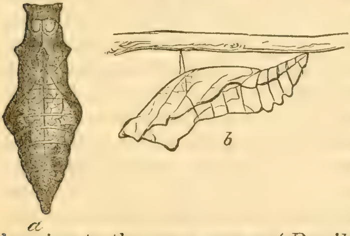
In the beautiful botanical grounds of Mr. Shaw, at St. Louis, there are some magnificent specimens of the Dutchman's Pipe, and about the end of last July, these had all been suddenly defoliated. I was invited to go and examine the cause and propose some remedy. I found the vines literally denuded, for there was not a whole leaf upon them, those that were not entirely eaten off down to the stem, being riddled with different sized holes. Upon a close examination, the authors of the mischief were soon found, in the shape of the peculiarly horned caterpillar, represented at Figure 84; but as there were few large specimens to be found, it was quite evident that the great bulk of them had acquired their growth, and had already left the vines for some more sheltered situation, in which to transform to the chrysalis state. There were, however, a sufficient number of smaller or more recently hatched individuals, had they remained undiscovered, to have soon taken every vestige of the few imperfect leaves remaining; while the beautiful butterflies which produced these worms were noticed flitting around the vines.

This insect is found on no other plants but the Aristolochias. The worms commence to hatch in this latitude by the beginning of July, from eggs deposited on the leaf; and individuals may be found as late as the last of August. They live in company, especially while young, and cover the leaves with zigzag lines of silk, which enable them the better to crawl about and hold on to the vines. The newly hatched worm is dark brown, with no spots, and with quite short tubercles. After the first month they become lighter colored, with the tubercles on the back of segments 6, 7, 8 and 9, of an orange color, and some of the other tubercles, especially the two on the first segment, proportionally longer than the rest. After the second moult the color of the body becomes still lighter, some of the tubercles still proportionally longer and longer, and those on the back all begin to appear orange; while a distinct orange spot becomes visible between the long horns on the first segment, from which spot the soft, forked orange scent-organs are thrust. After the third moult but very little change takes place, and after the fourth moult, the worm loses in a great measure its shiny appearance, becomes more velvety and darker, and when full grown presents the appearance of Figure 84, and may be described as follows:

Length, two inches. Color velvety black, with a slight purplish or chesnut-brown hue. Covered with long fleshy tubercles of the same color as body, and shorter orange colored tubercles, as follows: Two, which are brown, long, tapering and feeler-like, springing anteriorly one from each side of joint 1, the two being movable, and alternately applied to the surface upon which the worm moves. Joint 2, with two brown tubercles, one springing from each side with a downward curve, and each about one-third as long as those on joint 1; also with two small dorsal, wart-like orange tubercles. Joints 3 and 5 exactly like joint 2, but on joint 4 the lateral brown tubercle is replaced by a wart-like orange one. Joints 6, 7, 8 and 9, each with two small dorsal orange tubercles, and each with a lateral, elongated, pointed, brown, downwardly curved one, arising from the base of prolegs. Joints 10 and 11 also with these lateral tubercles, but the orange dorsal ones replaced by longer pointed curved brown ones, which however often have an orange base. Joint 12 with two somewhat stouter dorsal brown tubercles, but none at sides. Joints 7, 8, 9 and 10, each with a lateral orange spot just before and above the spiracles, which are sunk into the flesh and scarcely perceptible. Head, legs, venter and cervical shield the same color as body, the venter with two tubercles on joint 5, which much resemble prolegs, the cervical shield, with an orange transverse spot on anterior edge, from which is thrust the osmaterium.

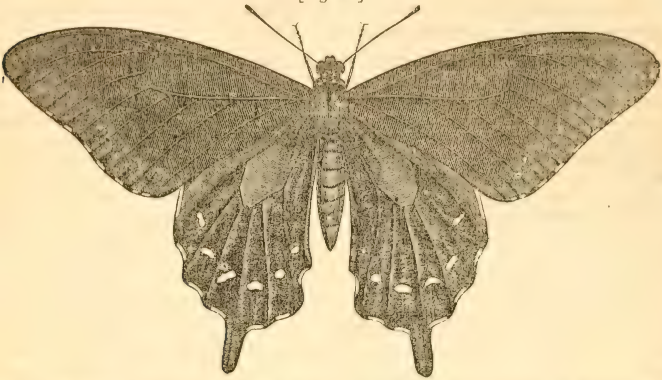
When full grown this tubercled worm fastens itself by its hind legs and by a silken loop drawn between joints 5 and 6, and in about two days changes to a chrysalis, of which Figure 85, *a*, gives a shaded back-view, and *b* a lateral outline. This chrysalis is at first yellowish-green, but soon becomes beautifully marked with gray and violet, and more or less with yellow on the back: and it is readily distinguished from all other chrysalides of North American butterflies belonging to the same genus (*Papilio*) by two trigonate prominences on the head which give it a square appearance; by a very prominent trigonate projection on the top, and a lesser one each side of thorax; by the wing-sheaths being much dilated and sharply edged above, and by six prominent, rounded, narrow edged, longitudinal projections on the top of the three principal abdominal joints.

[Fig. 85.]



The butterfly which issues from this chrysalis in about three weeks, is such a delicate and elegant object, that it is next to impossible to give a just illustration of it. The front wings are black with a greenish metallic reflection on the nerves and along the front and hinder borders, and a row of white spots near the hinder border, which is very slightly undulate, with a narrow cream-colored mark on the inner sinuses. The hind wings are of a brilliant steel-blue, with a greenish cast, with a carved row of white lunules and with the hinder border quite undulate and the inner sinuses cream-colored. The under surface of the front wings is more sombre than the upper surface, with the spots near the borders and the marginal lunules more distinct. The under surface of the hind wings, is on the con-

[Fig. 86.]



trary, with the exception of a large almost oval patch at base, of a very brilliant steel blue, with a curved row of seven rounded spots of a deep orange, bordered with black, and the four or five upper ones edged above with white; there is a small yellow basal spot, about five small whitish spots around the lower borders of the large sombre oval patch, and the marginal lunules are much more distinct than on the upper surface. The male which I illustrate (Fig. 86) differs from the female in the more brilliant hue of the upper surface, and in either entirely lacking the row of white spots near the hinder border of the front wings, or in having but the faintest trace of them.

As these Aristolochia worms are semi-gregarious, and as when young, all the individuals of a batch may be found close together, they are easily destroyed, and those persons who cultivate the Aristolochias, need never be troubled with this insect, if they will examine the vines carefully during the first half of July. The worms invariably produce butterflies during the fall months, and the insect consequently hybernates in the perfect or butterfly state. As the worms feed only on the Aristolochias, scarcely a plant of the kind can be grown without sooner or later being attacked, and the gardener should always keep a watchful eye for the worms, about the time indicated.

THE COTTONWOOD DAGGER—*Acronycta populi*, N. Sp.

(Lepidoptera Acronyctadæ.)

[Fig. 87.]

The Cottonwood tree (*Populus monilifera*), though not very generally cultivated in the more thickly settled parts of the country, is yet a valuable tree, especially in the newly settled parts of the West, where by its rapid growth and large foliage, it soon furnishes both wood and shade on the bleak treeless prairies. Besides several borers which eat into the trunk and root, it is attacked in this State by a very curious lazy caterpillar, which devours the foliage, and not unfrequently strips the tree.

This caterpillar (Fig. 87) when full grown, rests curled round upon the leaf, and is easily recognized by its body being covered with long soft bright yellow hairs which grow immediately from the body, part on the back, and curl round on each side. It has a shiny black head, black spots on the top of joints 1 and 2, and a straight black brush on top of joints 4, 6, 7, 8 and 11. There are two broods of these worms each year, the first brood appearing during the month of June and producing moths by the last of July, the second brood appearing the last of August and throughout September, and passing the winter in the chrysalis state. The chrysalis is dark shiny brown, and ends in an obtuse point which is furnished with several hooked bristles. It is formed within a pale yellow cocoon of silk intermingled with the hairs of the caterpillar, and is generally built in some sheltered place, such as a chink in the bark of a tree, or under the cap of some fence.

[Fig. 88.]

The moth (Fig. 88, ♀) is of a pale gray, marked with black as in the figure. It belongs to a night-flying genus (*Acronycta*) of true Owlet-moths, very closely allied to our common cut-worm moths; and yet the larvæ belonging to this genus have none of them the cut-worm habit of concealing themselves under ground, and are exceedingly heterogeneous among themselves. Some are furnished with long soft hairs like the species under consideration; some with prominent hairy warts; some have protuberances on certain segments; some are furnished with brushes; others not, etc., etc. But notwithstanding this dissimilarity among the larvæ of the genus, the moths bear very close resemblances to one another, and in some cases it is not easy to separate them without knowing the larvæ. Our Cottonwood species has never been described. It bears a strong resemblance to several European species, but as it would only weary the general reader to give the details wherein it differs from those already described, which closely resemble it, these details will be found to accompany the scientific description below.

This insect would undoubtedly become much more numerous and troublesome, were it not for the fact that it is pursued by three distinct parasites. Many of the worms when full grown will fasten themselves firmly to a leaf in the curled position, and from the body will issue from thirty to forty little maggots. These maggots are each of them 0.17 inch long, of a dull green color, tapering each way, with a dark dorsal mark, a lateral elevated ridge, and a row of shiny elevated spots of the same color as the body between this ridge and the back. Each one spins a mass of white silk around its body, and creeps out of it and commences spinning afresh, until at last a large aggregate amount of flossy silk is spun, into which the maggots work back to transform, though some transform while lying on the surface. These maggots eventually produce a little black Ichneumon-fly belonging to the genus *Microgaster*.* Another and larger undetermed Ichneumon-fly belonging to the genus *Ophion*, also attacks this Cottonwood worm, and it is also occasionally infested with a *Tachina*-fly larva.

These worms are most easily destroyed when young, for though not strictly gregarious, they do not then scatter much from the branch upon which they were born.

Acronycta populi, N. Sp.—*Larva*—Length 1.50. Color yellowish-green, covered with long soft bright yellow hairs which spring immediately from the body, part on the back, and curl round on each side. On top of joints 4, 6, 7, 8 and 11, a long straight double tuft of black hairs, those on 7 and 8 the smallest. Head polished black with a few white bristles. Joint 1 with a black spot above, divided longitudinally by a pale yellow line, giving it the appearance of a pair of triangles. Joint 2 with two less distinct black spots. Thoracic legs black; prolegs black with brownish extremities. Venter greenish-brown. Described from many specimens. When young of a much lighter color, or almost white, with the black tufts short but more conspicuous, with a distinct black dorsal line, two lateral purplish-brown bands, and with hairs white, sparse and straight.

Individuals vary much: some have a black dorsal line, some have but three distinct black tufts; some have a 6th tuft of black hairs on joint 9, and others have a few black hairs on all but the thoracic joints. Just before spinning up, many of the hairs are frequently lost, and the body acquires a dull livid hue.

Moth.—♀, Front wings, white, finely powdered with dark atoms which give them a very pale gray appearance; marked with black spots as follows: a complete series of small spots on posterior border extending on the fringes, one between each nerve; near the anal angle between nerves 1 and 2 a large and conspicuous spot bearing a partial resemblance to a Greek *psi*, placed sidewise, and from this spot a somewhat zigzag line running parallel with posterior border, but somewhat more arcuated towards costa, least distinct between nerves 3 and 4, and forming a large distinct dart-like spot between nerves 5 and 6; space between this line and posterior border, slightly darker than the rest of the wing-surface on account of the dark atoms being more thickly sprinkled over it; four costal marks, one subobsolete in a transverse line with the reniform spot, one conspicuous about the middle, and in a line with reniform spot and anal angle, one about the same size as the last and looking like a blurred X about one-third the length of wing from base, and one subob-

***Microgaster acronyctæ* of my MS.

solet, near the base; orbicular spot flattened and well defined by a black annulation; reniform spot indicated by a blurred black mark running on the cross-vein and sometimes somewhat crescent-formed; a V-shaped spot pointing towards base half-way between costa and interior margin, in a transverse line with the large costal spot which looks like a blurred X; a blurred mark in middle at base, and lastly a narrow spot on the inferior margin, half-way between base and anal angle. Hind wings same color as front wings; somewhat more glossy, with the lunule, a band on posterior border one-fourth the width of wing, and sometimes a narrow coincident inner line, somewhat darker than the rest; the posterior border also with a series of spots one between each nerve. Under surface of front wings pearly-white with an arcuated brown band, most distinct towards costa, across the posterior one-third, all inside of this band of a faint yellowish-brown; lunule and fringe spots distinct, and with a faint trace of the *psi*-spot; hind wings uniform pearly-white with a distinct and well defined dark wavy line running parallel with posterior margin across the posterior one-third of wing, and with the lunule and fringe spots distinct. Antennæ simple and bristle-formed, gray above, brown beneath. Head thorax and body, both above and below, silvery-gray. Legs with the tarsi alternately dusky and gray. ♂ differs from ♀ by his somewhat stouter antennæ; much narrower body, and narrower wings and fringes, the front wings having the apex more acuminate, and the hind wings scarcely showing the darker hind border.

Described from 2 ♀, 2 ♂ all bred. In the ornamentation of the front wings this species bears some resemblance to the European species *tridens* and *psi*, but otherwise differs remarkably, and especially in its larval characters. It bears a still closer resemblance both in the larva and imago state to the pale variety of a common species known in England as the "Miller" (*A. leporina*), but judging from the figures and description in "Newman's Natural History of British Moths," it may be easily distinguished from *leporina* by the well defined orbicular spot, by the greater proximity of the two large costal spots, by lacking a round spot behind the disk, and by the more prolonged apex. It differs also in the larva state from *leporina* which feeds on the Birch. It likewise closely resembles *interrupta*, though the larvæ are remarkably different; and it also resembles *lepusculina*, the larva of which is unknown; but the specific differences will be readily perceived upon comparing Guenée's descriptions. How near it approaches to *Acronycta occidentalis*, Grote,* it is impossible to tell, as the author's description is exceedingly brief, considering the number of closely allied forms; but as that species has a bright testaceous tinge on the reniform spot, it evidently differs from mine. Harris's *Apatela* [*Acronycta*] *Americana*,† though very different in the imago, yet closely resembles *populi* in the larva state. I have on two occasions found the larva of *Americana* feeding on the Soft Maple, and it may be distinguished from *populi*, by its greater size; by the paler color of the body; by the hairs being paler, more numerous, shorter and pointing in all directions, especially anteriorly and posteriorly of each segment; by having on each of joints 4 and 6 two distinct long black pencils, one originating each side of dorsum, and on joints 11 one thicker one originating from the top of dorsum; by a substigmatal row of small black spots (three to each segment, the middle one lower than the others) and by a trapezoidal velvety black patch starting from anterior portion of joint 11 and widening to anus.

THE MISSOURI BEE-KILLER—*Asilus Missouriensis*, N. Sp.

(Diptera Asilidæ.)

On page 168 of my First Report an account is given, with a very poor figure, of a large two-winged fly which was first received by Dr.

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*Proc. Ent. Soc. Phil., VI, p. 16.

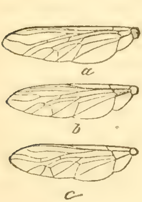
†I am surprised that Dr. Morris (*Harr. Inj. Insects*, p. 436, Note) refers this species to Guenée's *acericola*, when the larva of the latter, as described by Guenée himself, is so different and feeds withal on Birch and Alder, and not on either Maple, Elm, Linden or Chesnut.

[Fig. 89.]

Fitch, of New York, from Mr. R. O. Thompson of this State, who found that it had the pernicious habit of catching and sucking out the juices of the common honey-bee. Dr. Fitch referred this fly to the genus *Trupanea*, and called it the Nebraska bee-killer, from its having first been captured by Mr. Thompson in Nebraska, where he at that time resided. The great German Dipterist, H. Loew, as I am informed by Baron Osten Sacken of New York, ignores and has discontinued the genus *Trupanea*, substituting in its place that of *Promachus*; and Fitch's *Trupanea apivora* is the very same species previously described by Loew as *Promachus Bastardii*, and it is one of the most common species, occurring very generally over the United States.

I find that we have in Missouri a somewhat larger fly (Fig. 89) which has the same pernicious habit of seizing and destroying the honey-bee in preference to all other kinds of prey. It acts in exactly the same manner as the Nebraska Bee-killer, being, if anything, more inhuman and savage. It belongs to the typical genus *Asilus*, and I have called it the Missouri Bee-killer (*Asilus Missouriensis*). Though bearing a casual resemblance to the Nebraska Bee-killer, it may very readily be distinguished from that species, and especially by the different venation of the wings.

[Fig. 90.]



The three more common genera of these voracious *Asilus* flies, may easily be distinguished from each other by the character of these wing-nerves. In the typical genus *Asilus* to which belongs our Missouri Bee-killer, the *third* longitudinal vein is forked near the terminal *third* of the wing, and the vein itself is connected about the middle of the wing, with the fourth longitudinal, as in Figure 90, *b*. In the genus *Promachus*, to which the Nebraska Bee-killer belongs, it is the *second* (not the third) longitudinal vein which is forked near the *middle* of the wing, and the third branch of this fork is connected by a slender cross-vein to the third longitudinal, near the terminal third of the wing, as in Figure 90, *a*. In the genus *Erax*, which generally comprises smaller species, the venation is similar to that of *Asilus*, but the upper branch of the fork, instead of joining the third longitudinal vein, is abruptly broken off and connected only near its termination by a transverse vein, as in Figure 90, *c*.

ASILUS MISSOURIENSIS N. SP.—Alar expanse 1.85; length of body 1.30 inches. *Wings* transparent, with a smoky yellow tinge, more distinct around the veins, which are brown. *Head* pale yellow, sometimes brownish; moustache straw-yellow with a few stiff black hairs below; beard pale straw-yellow; crown very deeply excavated; base of the same pale yellow with short, stiff, yellowish hairs, and a crown of black ones near the border; eyes large, prominent, finely reticulated and almost black; antennæ, first joint black tipped with brown, cylindrical and hairy; second joint black, short, thick and rounded at tip, with a few stiff hairs; third joint as long as first, tapering each way, smooth, black and terminating in a long, brown bristle; proboscis black and nearly as long as face; neck with pale and black hairs. *Thorax* leaden-black, slightly opalescent with reddish brown at sides, more or less pubescent with pale yellow, especially laterally and posteriorly and in three narrow longitudinal dorsal lines which gradually approach towards metathorax; bearded at sides and behind with a few decurved black bristles, those behind interspersed with a few smaller pale hairs; scutel of the same color, with upward-curving, black bristles; halteres brown. *Abdomen*, ♂, general color dull leaden-yellow, with darker transverse bands at insections; the light color produced by a yellowish pubescence and numerous short close-lying yellow hairs, the dark bands produced by the absence of this covering at the borders of each segment; basal segment broad, bilobed, and with lateral black bristles; segments 6, 7, 8 and anal valves with a decided pink tint, especially 7; 8 but one-third as long as 7 above. ♀, broader, flatter, more polished and brassy, with no transverse darker bands, segments 7 and 8 polished black, the latter narrow and longer than any of the others; anus with a few black bristles. *Legs*, dull purple-brown, with black bristles; thighs very stout, the hind pair rather darker than the others, the two front pair of trochanters with long, yellowish hairs; pulvilli, generally fulvous.

Described from two ♂, and two ♀, all captured while sucking honey-bees. I have not access to Loew's descriptions, and cannot therefore compare it with already described species; but specimens have been sent to Dr. Wm. LeBaron, of Geneva, Illinois, and to Baron Osten Sacken, of New York, and both these gentlemen are unacquainted with it, and believe it to be new. In the well marked ♂ specimens, the body bears a general resemblance to that of *Trupanea* [*Promachus*] *vertebrata*, Say.

Of course the apiarian will care very little to know which of these two Bee-killers is weakening his swarms. They should both be unmercifully destroyed, and though very strong and rapid flyers, they may be easily caught when they have settled on any little prominence with a bee in their grasp; for they are so greedy of the bee's juices that they are at this time less wary, and even when disturbed, will fly but a few yards away before settling again. A net such as that described in the article on "Cabbage worms" will be found useful in catching these mischievous flies.

The habits and preparatory stages of our *Asilus* flies are not very well known. They are all cannibals in the fly state, sucking out the juices of their victims with the strong proboscis with which they are furnished, and by which they are capable of inflicting a sharp sting on the human hand. The larvæ are footless, and live in the ground, and such as are known in this state are strangely enough, vegetable-feeders.

[Fig. 91.]

The only N. A. species that has heretofore been bred to the perfect state, is the Silky Asilus (*Asilus sericeus*, Say., Fig. 91) belonging to the typical genus *Asilus*. Its larva feeds upon the roots of the Rhubarb, and was bred to the perfect state by Dr. Harris (*Inj. Insects*, p. 605). I have succeeded in breeding to the fly state another species, belonging however to the genus *Erax*, and subjoin a description of the larva, as it is of considerable scientific interest. The fly is figured below (Fig. 93 *a*).

[Fig. 92.]

ERAX BASTARDI (?)—*Larva*—(See Fig. 92.) Length 1.05 inches. Only twelve joints, the three anterior and the three posterior ones tapering gradually, the rest of equal width; slightly depressed; translucent yellowish-white, the chitinous covering tolerably firm however; a swollen lateral ridge; two rufous dorsal spiracles on joint 1 and two similar ones on joint 11. Head dark brown, very retractile, pointed, divided at tip into two mandibulate points, and having two unguiform appendages; anal segment with two depressed longitudinal lines above, ridged on anterior edge and with a central depressed line below. It makes use of its head in crawling.

Pupa—(Fig. 93 *b*). Stout, honey-yellow; the leg and wing-sheaths soldered together though separated from the abdomen; eyes large and dark; head with two large brown spines in front, and a lateral set of three rather smaller ones; thorax with two small thin rounded dorsal projections and a set of two small lateral spines just behind the head; abdomen, with each segment ridged in the middle and furnished on this ridge with a ring of brown blunt thorns sloping backwards; anal segment with a few rather stouter spines.

[Fig. 93.]

Two specimens, one found by Mr. G. C. Brodhead of Pleasant Hill, Mo., under a peach tree, the other by Mr. G. Pauls of Eureka, Mo., under a "creeping vine" of which he did not know the name. They were found full grown in May, and gave out the flies the fore part of July. Both produced ♀♀, on which account the species cannot be determined with absolute certainty. Osten Sacken informs me that it is allied to *tabescens* Loew, but is different. It is marked *lictor* in my MS., but from Macquart's description of *Bastardi*, and from ♂ and ♀ specimens of that species kindly furnished by Dr. Le Baron, I feel pretty confident that it is ♀ of that species, which is described as follows: *Abdominis segmentis tribus apicalibus niveus* ♂; *omnibus segmentis albido marginatis* ♀. *Pedibus nigris: tibiis rufis: alis flavidis. Long.* 7½ l. He then adds: "Face and front black with gray down; moustache with the upper half black and lower half white; as also the beard. The middle band of thorax divided. The first four segments of the abdomen with the posterior and lateral borders whitish. Extremities of the legs black. From North America. From 3 ♂, I have seen one which had the four terminal segments of the abdomen white." My females accord very well with this description so far as it goes, though I cannot see why Macquart restricts the whitish borders to the first four segments in the French description, when in the Latin it is stated that all the segments are so bordered, which is the case with my specimens.

INNOXIOUS INSECTS.

THE GOAT-WEED BUTTERFLY—*Paphia glycerium*, Doubleday.

[Lepidoptera, Nymphalidæ.)

[Fig. 94.]

There is is an interesting and rare butterfly known to entomologists by the name of *Paphia glycerium*, which occurs in Missouri, Texas and Illinois, and perhaps in other southwestern States. It is an interesting species on account of the dissimilarity of the sexes, and of the position it holds among the butterflies; and as its natural history was unknown till the present year, I will transcribe from the *American Entomologist*, the following account of it, which I was enabled to prepare from specimens kindly sent to me last September by Mr. J. R. Muhleman, of Woodburn, Ills., and from further facts communicated by Mr. L. K. Hayhurst, of Sedalia, Mo.

Dr. Morris, in his "Synopsis of the Lepidoptera of North America," places this butterfly with the *Nymphalis* family, of which the Disippus Butterfly (*Nymphalis disippus*, Godt.), is representative. The larva, however, has more the form and habits of that of the Tityrus Skipper (genus *Goniloba*), while singularly enough, the chrysalis resembles that of the Archippus Butterfly (genus *Danais*).

The larva feeds on an annual (*Croton capitatum*) which is tolerably common in Missouri, Illinois, Kentucky, and westward, where it is known by the name of Goat-weed, and as no value whatever is attached to it, the insect which attacks it cannot be classed among the injurious species. The plant has a peculiar wooly or hairy whitish-green appearance, and in the month of September its leaves may frequently be found rolled up after the fashion shown at the left of Figure 94, with the larva inside. This roll of the leaf is generally quite uniform, and is made in the following manner: Extending itself on the midvein, with its head towards the base of the leaf, the larva attaches a thread to the edge, at about one-fourth the distance from the base to the point. By a tension on this thread, it draws this edge partly toward the opposite one, and fastens it there, being assisted in the operation by the natural tendency of the leaf to curl its edges inwards. Fastening a thread here, it repeats the operation until the edges meet, and then it proceeds to firmly join them nearly to the apex, leaving a small aperture through which to pass the excrement. During hot days the larva remains concealed in the leaf, and towards evening comes out to feed, though sometimes it feeds upon its house, eating the leaf down half way from base to point. It then abandons it and rolls up a new one. In the breeding cage, when placed in a cool shady room, the larva seldom rolls up the leaves, but feeds at random over the plant, and when at rest simply remains extended on a leaf. From this we may infer that its object in rolling the leaves is to shield itself from the rays of the hot August and September sun; for the plant invariably grows on high naked prairies.

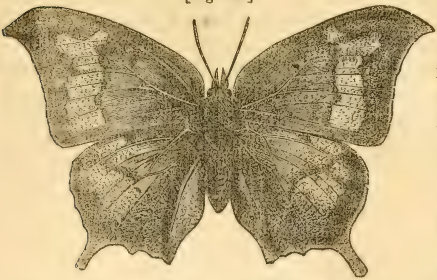
[Fig. 95.]

The young larva has a large head, larger than the third segment, which is the largest in the body. The head preserves its general form through the successive moults; it is light bluish, thickly covered with papillæ of a dirty-white color, and there are also a number of light orange papillæ of a larger size scattered among them. The skin of the caterpillar is *green*, but the general hue is a dirty-white, owing to the entire surface being very closely studded with white or whitish papillæ with dark-brown ones interspersed. These prominences are hemispherical, hard, opaque, shining, and the larva feels rough and harsh to the touch.

At each moult some of these papillæ disappear, especially *all* the brown ones, the body increases in size so that the head is smaller than the third segment, the green color of the skin becomes more apparent, the body is softer to the touch, and the whole larva assumes a neater appearance.

Thus this larva has very much the same peculiar whitish glaucous-green color as the plant on which it feeds; and any one who has seen it upon the plant, cannot help concluding that it furnishes another instance of that mimickry in Nature, where an insect, by wearing the exact colors of the plant upon which it feeds, is enabled the better to escape the sharp eyes af its natural enemies. When full-grown, which is in about three weeks after hatching, this worm (Fig. 94, *a*) measures 1½ inches, and although, as above described, the little elevations frequently disappear so that it looks quite smooth, yet sometimes they remain until the transformation to chrysalis takes place, as was the case with two which I bred.

[Fig. 96.]



Paphia glycerium.—*Full-grown larva*—Length 1.50 inches. Cylindrical. General appearance shagreened, pale glaucous-green, lighter above stigmata than elsewhere. Ground-color, of body clear green. Thickly covered with white papillæ or granulations, which are often interspersed with minute black or dark-brown sunken dots. Head quite large, (rather more than ½ as large as the third segment), nutant, subquadrate, bilobed, granulated like the body, but with the black sunken dots more numerous, and having besides, several larger granulations above, some four of which are generally black and the rest fulvous; a row of three very distinct eye-spots at the base of palpi; the triangular V-shaped piece elongated and well defined by a fine black line, and divided longitudinally by a straight black line; palpi and labrum pale. the latter large and conspicuous; jaws black. Neck narrow, constricted, green, smooth, and retractile within first segment. Segments 1—3 gradually larger and larger; 3 to last gradually smaller. Stigmata fulvous. Venter less thickly granulated than tergum. Described from five full-grown specimens received from Mr. Muhleman.

Preparatory to transforming, it suspends itself by the hind legs to a little tuft of silk which it had previously spun, and after resting for about twenty-four hours with its head curled up to near the tail. it works off the larval skin and becomes a chrysalis, which in from two to three weeks afterwards gives out the butterfly. This chrysalis (Fig. 94, *b*) is short, thick, rounded, and of a light green; sometimes becoming light gray, and being finely speckled and banded with dark gray. The skin is so thin and delicate that the colors of the butterfly may be distinctly seen a few days before it makes its escape.

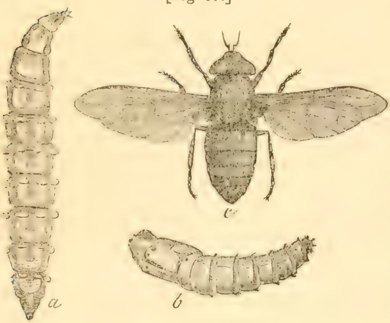
The male butterfly (Fig. 95), is of a deep coppery-red on the upper side, bordered and powdered and marked with dark purplish-brown, as shown in the figure. The under side is of a *feuille morte* brown with a greasy lustre, the scales being beautifully shingled transversely so as to remind one of that article of dry-goods which the ladies call rep; while the bands which commenced on the front wings above, may be traced further across the wing, and there is a transverse band on the hind wings, with an indistinct white spot near the upper edge. The female (Fig. 96), is of a lighter color than the male, marked with purplish-brown as in the figure, the transverse bands being quite distinctly defined with very dark-brown. The under side is very much as in the male.

A few of the butterflies, in all probability, manage to live through the winter, and are thus enabled to perpetuate the race, by depositing their eggs, the following summer, on the leaves and stems of the Goat-weed, which is the only plant upon which the insect is yet known to subsist.

THE BLACK BREEZE-FLY—*Tabanus atratus*, Fabr.

(Diptera, Tabanidæ.)

[Fig. 97.]



There is a family of large Two-winged Flies, commonly called Breeze-flies in England, but more commonly known as Horse-flies in this country, the insects belonging to which are, in the perfect state, great nuisances, though there is every reason to believe that as larvæ they are beneficial to the husbandman, by devouring many noxious underground vegetable-feeding larvæ.

This family comprises some of the very largest flies, and they are all noted for the tormenting powers which the female has of piercing the skin and sucking the blood of different quadrupeds and even of man. They are widely distributed, and species occur in all parts of the world, torturing alike the huge elephant and fierce lion of the tropics, and the peaceful reindeer of the arctic region. It is during the hottest summer months that they "do most abound," and they frequent both our timbered and prairie regions. One of the most common species in the West is the so-called "Green-head Fly" (*Tabanus lineola*, Fabr.) and every farmer who has to work on the prairies, especially during the hay-making season, knows how bloodthirsty it is, and how absolutely necessary it is to cover the horses at this season of the year, in order that they may be able to work at all. Two other species of nearly the same size (*T. costalis*, Wied. and *T. cinctus*, Fabr.) are common with us, and I have found the striped

Chrysops (*Chrysops vittatus*, Wied.)—a smaller yellow species with black stripes, and a broad smoky band across the middle of each wing; to be very troublesome in our wooded regions, confining its attacks more especially to the horses' ears, from which habit it is frequently called the "Ear-fly."

It is only the female flies, as is the case also with our mosquitoes, which thus torment our animals by means of their sharp lances, the males living on the sweets of flowers, and their mouths being destitute of mandibles. The flight of these Breeze-flies is very strong and rapid, and is attended with a buzzing, tormenting noise. The males may often be seen with the wings vibrating so rapidly that they become invisible, resting motionless in one place, and then darting rapidly and resting suddenly again, generally turning the head in some other direction each time they dart; and St. Fargeau has ascertained that this manœuvering is performed in order to intercept and seize the females.

Although these flies swarm so prodigiously on our prairie and especially on our low swampy lands, yet hitherto very little has been known of their larval character and habits. De Geer very many years ago described the larva of the European Cattle Breeze-fly (*Tabanus bovinus*, Linn.), and up to 1864 this was the only larva of the kind known. In February of that year Mr. Walsh published the description of another Tabanide larva, but without being able to refer it to any particular species.* I had the good fortune last summer to breed to the perfect state the very same kind of larva which Mr. Walsh described. It proved to be one of our most common and largest species, namely The Black Breeze-fly (*Tabanus atratus*, Fabr.) This Fly (Fig. 97, *c*) is black, the back of the abdomen being covered with a bluish-white bloom like that on a plum; the eyes are large, and the wings are smoky dark brown or black.

The larva (Fig. 97, *a*) is a large 12-jointed, cylindrical affair, tapering at each end, of a transparent, highly polished, glassy, yellowish or greenish appearance, shaded with bluish-green and furnished above and below, as in the figure, with large roundish sponge-like tubercles which are retracted or exserted at the will of the insect. Though the external integument is so transparent, that the internal structure is readily visible, yet this integument is firm and the larva is most vigorous and active, burrowing with great strength either backwards or forwards in the earth, and between one's fingers while it is being held. Placed in water it will swim vigorously by suddenly curling round and lashing out its tail, but it is apparently not as much at home in this element as in the wet earth, for it is restless and remains near the surface, with the tip of the tail elevated in the air. When the water is foul it moves about actively near the surface, but when it is fresh it remains more

*Proc. Bost. Soc. Nat. Hist., Vol. IX, pp. 302–6.

quiet at the bottom. The specimen which I succeeded in breeding, was sent to me by Mr. Adolph Engelmann of Shiloh, St. Clair Co., Ills. It was found by Mr. Wm. Cooper of the same county, about ten feet from a small but permanent stream of water. Mr. C. at first took it to be a leech, and when he attempted to capture it, it immediately commenced burrowing in the ground.

Mr. Walsh's description of this larva is so full, and agrees so well with mine, that I cannot do better than transcribe it.

TABANUS ATRATUS.—*Larva,*—Length 2.25 inches when extended, 1.75 inches when contracted: diameter .25—.30 inch. Body cylindrical, 12-jointed, the three or four terminal joints much tapered at each end of the body, but more so anteriorly than posteriorly, and joints 1 and 11, each with a retractile membranous prolongation at tip. Joints 1 to 10 are subequal; 11 is about two-thirds as long as 10 and 12 about one-fourth as long, and .05 inch in diameter. [Joints 1 and 12 pear-shaped when extended]. Color a transparent greenish-white, paler beneath; an irregular dark-green or greenish-black annulus, paler beneath, on the anterior and posterior margins of joints 2 to 11, the anterior annulus laterally connected with the posterior by two to four dark-green lines. On the dorsum of 4 to 9, and more obscurely on 10, a dark-green basal triangle, extending half-way to the tip; joint 1 with paler markings, and with no dark annulus behind; joint 12 entirely fuscous. Head small, apparently fleshy, pale, truncate-conical, .03 inch wide, and about .04 inch long in repose, inserted in joint 1 without any shoulder. The trophi occupy two-thirds of its length, but it has a long cylindrical internal prolongation, extending to the middle of joint 2, which is sometimes partially exserted, so that the head becomes twice as long as before. All the trophi are pale and apparently fleshy, except the mandibles, which are dark-colored and evidently horny, and they have no perceptible motion in the living insect. The lubrum is slender, a little tapered, and three times as long as wide, on each side of and beneath which is a slender, thorn-like, decurved, brown-black mandible. The labium resembles the labrum, but is shorter, and on each side of it is a slender palpiform, but exarticulate maxilla, extending beyond the rest of the mouth in an oblique direction. No palpi. On the vertex are a pair of short, fleshy, exarticulate, filiform antennæ, and there are no distinct eyes or ocelli. In the cast larval integument the entire head, .25 inch long, is exserted, and is dark-colored and evidently horny, all the parts retaining their shape except the antennæ, labrum and labium. The whole head has here the appearance of the basal part of the leaf of a grass-plant, clasping the origin of the maxillæ on its posterior half, and bifurcating into the somewhat tapered cylindrical mandibles on its anterior half. The maxillæ are traceable to two-thirds of the distance from the tip to the base of the head, scarcely tapering, bent obliquely downwards at two-thirds of the way to their tip, and obliquely truncate at tip. On the anterior margin of ventral segments 4—10, in the living insect, is a row of six large, fleshy, roundish, tubercular, retractile pseudopods, the outside ones projecting laterally, and each at tip transversely striate and armed with short, bristly pubescence; on the anterior half of ventral joint 11 is a very large, transversely-oval, fleshy, whitish, retractile proleg, with a deeply impressed, longitudinal stria. On the anterior margin of dorsal joints 4—10, is a pair of smaller, transversely-elongate, retractile, fleshy tubercles, covering nearly their entire width, armed like the pseudopods, but not so much elevated as they are. No appearance of any spiracles. Anus terminal, vertically slit with a slender, retractile thorn .05 inch long, not visible in one specimen. Head, and first segment or two, retractile.

The larva reared by De Geer was terrestrial. This larva is semi-acquatic, for it is quite at home either in water or moist earth. My specimen was kept for over two weeks in a large earthen jar of moist earth well supplied with earth-worms. It manifested no desire to come to the surface, but burrowed in every direction below. I found several pale dead worms in the jar, though I cannot say positively whether they had been killed and sucked by this larva. Mr. Walsh in speaking of its haunts and of its food, says: "I have, on many different occasions, found this larva amongst floating rejectamenta. On one occasion I found six or seven specimens in the interior of a floating log, so soft and rotten that it could be cut like cheese. Once I discovered a single specimen under a flat, submerged stone, in a little running brook. And finally, I once met with one alive, under a log, on a piece of dry land which had been submerged two or three weeks before, whence it appears that it can exist a long time out of the water. I had, on several previous occasions, failed to breed this larva to maturity, and the only imago I have, was obtained in 1861, from larvæ, which, suspecting them to be carnivorous from the very varied stations in which they had occurred, I had supplied with a number of fresh-water mollusks, but the habits of which, in consequence of having been away from home, I was unable to watch. On September 2d, 1863, I found a nearly full-grown larva amongst floating rejectamenta, and between that date and September 23d, he had devoured the mollusks of eleven univalves (*Gen. Planorbis*) from one-half to three-fourths of an inch in diameter; and on three separate occasions I have seen him work his way into the mouth of the shell. In this operation his pseudopods were energetically employed, and I found, on cracking the shells after he had withdrawn, that a small portion of the tail end of the animal was left untouched—no doubt in consequence of his being unable to penetrate to the small end of the whorl of the shell—and also the skin of the remaining part, and the horny-tongued membrane."

My larva transformed to pupa (Fig. 97, *b*) within the ground, during the fore part of July; it remained in this state but a few days, and the fly issued July 13th, and soon made its presence known by its loud buzzing inside the jar. It was a perfect ♀ specimen, and the pupal integument was sufficiently firm and polished, that by carefully washing off the earth, an excellent cabinet specimen was obtained, which retained almost the exact form and appearance of the living pupa. Before the escape of the fly which was effected through a longitudinal fissure on the back of the head and thorax, reminding one of the mode of escape of our Harvest-flies (*Cicadæ*), this pupa by means of the thorns with which it is furnished, had pushed itself up to the surface of the earth. My specimen being female, may account for the very slight difference between the following description and that of Mr. Walsh's.

Pupa, (described from pupal integument).—Cylindrical, lying curved as in the figure; rounded at the head, and tapering at the last two joints; pale semi-transparent yellowish-brown. *Head* with two transverse, narrow-edged, somewhat crescent-shaped dark-brown projections representing the mouth, two rounded tubercles above, on the front, of the same color, and each giving out a stiff bristle; and midway between these four, two much smaller, lighter, rounded tubercles, set closer together; on each side in a line with the upper tubercles, a wrinkled antenna, trigonate at base, appressed to the surface and pointing outwards; below these antennæ, on the eyes, two small bristled warts. *Thorax*, pronotum commencing behind antennæ, with a pair of small bristled brown tubercles* on its anterior dorsal submargin; mesonotum twice as long as pronotum, with a pair of large obliquely-placed, reniform, purple-brown tubercular spiracles, bordered on the outside above, with a distinct fine white line; between these spiracles are four small brown elevations the two middle ones quite small and close together; a short metanotal piece, about one-seventh as long

*Evidently not spiracles as Mr. Walsh supposed. The mesonotal spiracles are well defined, with the white border above mentioned, and the abdominal spiracles are each marked behind by a distinct white line; but these tubercles have no such annulus and are illy defined.

as pronotum and without spiracles. *Abdomen*, with 8 subequal segments, with two well defined lateral impressed lines, and all but the last bearing between these lines, a rounded brown tubercular spiracle, the posterior upper borders lined with white. The first segment is simple and extends to the tips of the wing-sheaths; the others are all furnished, on the posterior one-third, with an annulus of fine, yellowish bristles, depressed and directed backwards. Anal thorn robust, yellow, truncated, and furnished with six stout brown thorns, hexagonally arranged. Length 1.29 inches; greatest diameter 0.30 inch. One ♀ specimen.

This large Black Breeze-fly does not attack horses to any considerable extent that I am aware of, but is said to bite cattle. The smaller species of real Horse-flies mentioned above, and which occur in prodigious numbers on our Western prairies, away from any large streams of water, must evidently be terrestrial in the larva state, and not aquatic, and must just as surely live on other food than snails, which are quite rare on the prairies. They are certainly carnivorous however, and it is but natural to suppose that they feed on underground vegetable–feeding larvæ, such as the different kinds of white grubs, the larvæ of Crane-flies (*Tipulidæ*), etc. Thus, in all probability, they perform a most important part in the economy of Nature, by checking the increase of those underground larvæ which are the most unmanageable of the farmer's foes. They therefore partly atone for the savage and blood-thirsty character of the perfect females, and I prefer consequently to place them with the other Innoxious Insects.

GALLS MADE BY MOTHS.

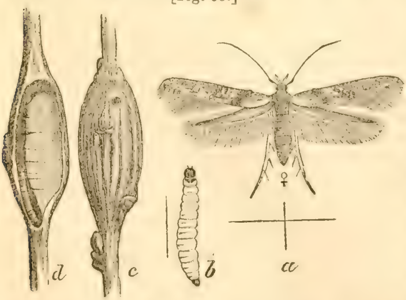
As a sequence to the article on the Solidago Gall Moth (*Gelechia gallæsolidaginis*, Riley) published in my former Report, I will here describe two other gall-making moths, with which I was not then acquainted, the first of which, as I have since ascertained, occurs in this State. The other I have never yet met with.

THE FALSE INDIGO GALL–MOTH—*Walshia amorphella*, Clemens.

(Lepidoptera, Tineidæ.)

On the leafless stems of the False Indigo (*Amorpha fruticosa*) may often be seen, during the fall, winter and spring months, an elongated swelling such as that shown at Figure 98, *c*, two of them often occurring one above the other. This swelling is a simple enlargement of the stem to five or six times its natural diameter, and measures from three-quarters of an inch to an inch in length. If cut open during any of the winter months, the interior will present a tough woody appearance, with an irregular brown channel, almost always

[Fig. 98.]



at one side of the gall, and communicating above with a small closed-up tubercle (See Fig. 98, *d*,). At the bottom of this channel the larva (Fig. 98, *b*, enlarged), which is whitish with a conspicuous black head and black collar, may always be found, and it does not transform to the chrysalis state till a few weeks before appearing as a moth. The tubercle near the top of the gall is evidently caused by the young larva penetrating the stem when it first hatches out; and this larva must, after it has burrowed the proper length down the stem, turn round and widen the burrow right up to the point of entrance; for it is from this point that the moth escapes in the spring. The moth, of which Figure 98, *a*, represents an enlarged female, is easily distinguished from most other small moths belonging to the same family (*Tineidæ*) by its beautifully tufted front wings, which are not easily represented in a wood-cut. It is of a yellowish-brown color, marked with darker brown, and the males are generally a little darker than the females. This little moth was first described by Clemens (Proc. Ent. Soc. Phil., Vol. II, p. 419), who named the genus in honor of Mr. Walsh, its first discoverer, and so far as I am aware it is the only representative of the genus.

The twigs invariably wither and dry up above this gall, but as the shrub has no particular value, the little gall-maker may be placed among the harmless insects.

WALSHIA AMORPHELLA—*Larva*—Length 0.35—0.40 inch. Cylindrical, tapering each way, but more especially towards anus. Yellowish-white, each segment with about two distinct transverse folds. Two dorsal rows of pale but polished piliferous spots, two to each segment; stigmata round, jet black with a white centre, with a pale piliferous spot above, and two contiguous ones on a lateral fold, below each; on joints 1 and 2 the folds are more numerous and the piliferous spots are larger and arranged in a transverse row. Head either black or dark brown, the trophi except the maxillæ white, and the eyelets, arranged in a crescent, also pale. Cervical shield same color as head, divided in the middle by a distinct pale line. Both have a few white hairs, arising from pale points. Anal shield small and brown. Thoracic legs pale but slightly horny, transparent, furnished with hairs, and with two basal semi-circular brown lines behind, the largest terminating on the inside, in a black thorn. Prolegs very small and scarcely distinguishable except by a faint brown circular rim at extremities, and a still fainter one at their base. Described from numerous specimens, all very uniform.

Pupa—Unknown.

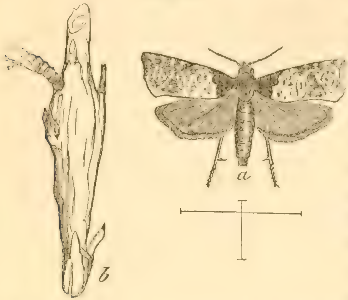
Moth—Front wings yellowish-fuscous, with a rather large blackish brown patch at the base of the wing, somewhat varied with spots of the general hue, and a blackish-brown tuft, having the scales directed toward the tip of the wing, on the basal third of the fold, and a smaller one above it near the costa. Near the end of the fold is another small tuft of the general hue, having the ends of the scales tipped with dark brown, and in the middle of the wing nearly adjoining the latter is a large tuft of the general hue. Above the end of the fold is a small blackish-brown tuft, the scales of which are not so much erected as in the other tufts; between this and the central tufts is a blackish-brown patch which sends a streak of the same hue into the fold. The apical portion of the wing is somewhat discolored with brown, and along the inner margin, at the base of the cilia, are five or six black dots. Cilia dull testaceous. [Hind wings shiny yellowish-brown, long, narrow, lanceolate, with very long cilia] Antennæ fuscous [the basal joint long, smooth and clavate]. Head and thorax blackish-brown; labial palpi yellowish-fuscous. [Abdomen above dark brown, the joints bordered behind with gray, the terminal joint with a yellow tuft. Legs short, the tarsi only of hind pair reaching beyond abdomen; marked with gray and brown. Under surface uniform grayish-brown, the hind wings somewhat paler, and all the wings bordered with a paler line. Length 0.20; alar expanse 0.53 inch.] (After Clemens).

THE MISNAMED GALL-MOTH—*Euryptychia, saligneana*, Clemens.

(Lepidoptera, Tortricidæ.)

The only other gall-producing moth known in this country is the species illustrated herewith (Fig. 99, *a*), and there are some doubts in my mind as to whether it is a real gall-maker or an "inquiline" or intruder on my true Solidago Gall-maker (*Gelechia gallæsolidaginis.*) But two specimens of the moth have ever been found, one of which is in the cabinet of the late Brackenridge Clemens, at Philadelphia, and the other in my possession. They were both bred by Mr. Walsh from golden rod galls resembling those of my Solidago gall in being elongated and hollow; and from specimens kindly furnished to me before his death, I am enabled to give the above sketch of the dried gall, with the pupa-skin attached, and likewise that of the moth. The only description which exists of the larva is of a dead and somewhat shrunken specimen, in the following brief note taken from Mr. Walsh's journal: "Larva 16-footed, yellowish; spiracles (fuscous) on all but 2d, 3d and anal segments. Head and 2d [1st] segment horny and rufous. Length 0.40."

[Fig. 99.]



The moth is the only representative of its genus (*Euryptychia*) so far known. It was described in 1865 by Dr. Clemens * as *E. saligneana*, under the false impression that it was reared from a willow gall. But the scientific name of the insect must stand, however inappropriate.

EURYPTYCHIA SALIGNEANA—*Moth*—Front wings white, tinted with yellowish. The basal patch is dark brown. The wing beyond the basal patch is nearly white, varied with leaden-colored speckles and striped over the nervules with dull, leaden-gray, transverse stripes, two of which near the anal angle form a white ocelloid patch. Immediately interior to the ocelloid patch is a small black spot, having a line of black atoms running into it, from above and beneath. Below the apex, on the hind margin, is a triangular brown patch, which is varied with grayish and dotted with black in the middle and along the inner edge. The costa is geminated with white, and striped with brown. Hind wings dark fuscous. (After Clemens.)

Generic character—Hind wings broader than front wings. Costal and subcostal veins with a common origin; branches of subcostal connivent. Median vein 4-branched, three of which are aggregated, the two central ones from a common base. Front wings *with a broad fold*, extending to the middle of the costa, closely appressed; at least three times longer than broad; costa straight, tip moderately acute, apical margin rounded. The nervules given off from the posterior end of the cell are bent toward each other or are somewhat aggregated.

Head smooth, with ocelli at base of antennæ. Antennæ filiform, simple. Labial palpi, *do not exceed the face*, are curved, smooth, rather slender, expanded toward the tip, the apical joint scarcely perceptible, except in front. (Clemens.)

My reasons for thinking this insect an intruder on the rightful gall-maker, are: 1st, because if it were a true gall-maker we should

* Proc. Ent. Soc., Phil., V., p. 141.

naturally expect to find its gall more common; 2d, because on several occasions I have found within the *Gelechia* gall, a pale worm very different from the true gray gall-making larva. But until more decided proof can be obtained, and until the fact is settled by further experience and experiment, we must, from such evidence as we have, consider the Misnamed Gall-moth, a true gall-maker.

Thus we have three different and distinct gall-moths in this country, belonging to two distinct families and three distinct genera; while a fourth (*Cochylis hilarana*) belonging to still another genus is known to form a gall on the stems of *Artemisia* in Europe. It is very manifest that all of these galls are formed by the irritating gnawings of the larva after it is hatched, and not induced by any poisonous fluid injected with the egg by the ovipositor of the parent, as is demonstrably the case with those galls which are produced by gall-flies (*Cynips* family), and with such as are produced by some gall-making Saw-flies. It is not at all improbable, however, that these moth larvæ do in reality secrete from the mouth some peculiar fluid which tends to produce the gall; for we know that very many other moth larvæ burrow in the stems of different plants without producing any abnormal swelling.

ERRATA.

Page 13, line 25, for "cupable" read "culpable."

Page 16, line 13, for "lava" read "larva"

Page 23, line 6 from bottom, for "hole" read "holes."

Page 32, line 17, for "insect" read "insects."

Page 50, line 4 from bottom, for "*leucaiæ*" read "*leucaniæ.*"

INDEX.

A

B

C

D

E

F

G

H

I

L

M

N

O

P

R

S

THIRD ANNUAL REPORT

ON THE

NOXIOUS,

BENEFICIAL AND OTHER

INSECTS,

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY, MO.:
HORACE WILCOX, PUBLIC PRINTER.

1871.

PREFACE.

To the Members of the Missouri State Board of Agriculture:

Gentlemen: I herewith submit for publication, my Third Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

No particular action seems to have followed the suggestions thrown out in my last year's preface, as to the procuring of a better quality of paper and ink for these Reports. The impressions of the cuts which illustrate the text, are consequently quite inferior in my second Report, and fail to do justice to the engravings.

As will be seen from the following pages, many important discoveries in Economic Entomology have been made during the year, and some few insects have been very abundant. On the whole, however, we have enjoyed more than the usual immunity from insect depredations throughout the State. Complaints have been numerous, and articles giving extravagant accounts of the increase of noxious insects are continually appearing in our agricultural papers. But while some insects are on the increase, others are on the decrease, and the cause for alarm is in a great measure imaginary. More is now said and written about insects in the industrial journals of the State than formerly, because, through the agency of these Reports, the people have had their eyes opened to the importance of the subject; and the impression that insects generally are on the increase must be, in a great measure, attributed to this fact rather than to any real increase that has occurred.

The *American Entomologist*, in the columns of which some of the observations contained in this Report have already appeared, was continued during the year, and a botanical department, edited by Dr. George Vasey, of Normal, Illinois, was added to it. The charge of such a journal, together with my State duties, kept me too much confined, and for these and other reasons given, the magazine has been suspended during the coming year, 1871.

This suspension will enable me to spend more time in the field, and as these annual Reports have but a limited circulation, and as very many cultivators of the soil must in consequence, fail to get the information contained in them, I have concluded to devote more time the coming year to lecturing; and have already prepared for that purpose a number of large, colored illustrations.

I am satisfied that by this means I can materially add to the good effected by these Reports, and I shall endeavor to fill any engagements which the officers of our county agricultural and horticultural societies may desire to make, providing they give me notification a sufficient time beforehand.

In the following pages the same rules are complied with as were laid down in my first Report. When the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. The popular name of each insect is accompanied by the scientific name, and the latter is always printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, is also given under each heading. The dimensions are expressed in inches and the fractional parts of an inch, and the sign ♂ wherever used, is an abbreviation for the word "male," the sign ♀ for "female," and the the sign ☿ for neuter. It must also be recollected that many of the figures are magnified, and that the hair line at the side of such gives the natural size.

The scientific reader will notice that some of the insects are referred to the old instead of the more modern genera, and this course has been pursued because the generic nomenclature is constantly changing, and because the old name has often become thoroughly associated with the insect in the mind of the practical man, who would be confused by, and is not interested in, the nice changes taking place in classification.

All the illustrations in this, as in the previous Reports, have been drawn from life by myself, or under my direct care, unless otherwise stated.

I have secured a pleasant office, connected with that of your Secretary, at Room 29, Insurance Building, Southeast corner of Fifth and Olive streets, St. Louis, and all letters sent to me should be thus addressed.

My acknowledgments are due to the Superintendents of the following railroads, for free passes over their respective routes: The Pacific Railroad of Missouri, Atlantic and Pacific, St. Louis and Iron Mountain, Hannibal and St. Joseph, North Missouri, Chicago and St. Louis, Illinois Central, and the Rockford, Rock Island and St. Louis.

All which is respectfully submitted by

CHARLES V. RILEY,
State Entomologist.

ST. LOUIS, MO., December 2, 1870.

NOXIOUS INSECTS.

SNOUT-BEETLES.

(Coleoptera Curculionidæ).

AN ACCOUNT OF SOME OF THOSE SPECIES WHICH ARE INJURIOUS TO FRUITS AND VEGETABLES.

In my First Annual Report I gave an account of the common Plum Curculio, which was as complete as our knowledge of the insect would then permit. Since the publication of that Report many new and most important facts, relating to this insect, have been brought to light, and I deem it wise in this review of some of our more injurious snout-beetles, to lay these facts before the reader. Many of them were embodied in an essay read by myself at the Fifteenth Annual Meeting of the Illinois State Horticultural Society, recently held at Galesburg, in that State, and therefore, with some important additions, I reproduce that essay, which embraces the first five insects here treated of.

Insects, like other animals, derive their nourishment from the vegetable and animal kingdoms; but a glance is sufficient to show that they possess a far greater field of operations than all the other animals combined. Indeed, the food of insects is a theme so large that I might occupy page after page by dwelling upon it alone. The other animals use as food but a very small portion of the inexhaustible treasures of the vegetable kingdom, and the remainder is unpalatable or even poisonous to them. Not so with insects, for, from the gigantic *Banyan* which covers acres with its shade, or the majestic Oak, to the invisible fungus, the vegetable creation is one vast banquet, to which they sit down as guests. The larger plant-feeding animals are also generally confined, in their diet, to the leaves, seeds or stalks, being either foliaceous or farinaceous; but insects make every possible part of a plant yield them valuable provender. We have an excellent illustration of this omnipresent character of insects in those species which are well known to attack the common apple tree. Thus, beginning at the root, we find it rendered knotty and unhealthy on the outside by the common Root-louse (*Eriosoma pyri*, Fitch), while the heart is often entirely destroyed by one or the other of two gigantic Root-borers (*Prionus imbricornis*, Linn, and *P. laticollis*, Drury). The trunk is riddled by the larvæ of several Long-horn beetles, and pre-eminently by the Two-striped Saperda (*Saperda bivittata*, Say), as well as by other smaller beetles; the liber and alburnum are destroyed by the Flat-headed borer (*Chrysobothris femorata*, Fabr.), the outer bark eaten by bark beetles (*Scolytus* family) and sucked by Bark-lice peculiar to it. The branches and twigs are bored along the axis and pruned by the larvæ of the common Pruner (*Elaphidion villosum*, Fabr.), and by that of the Parallel Pruner (*E. parallelum*, Lec.), girdled by the Twig-girdler (*Oncideres cingulatus*, Say*), sawed and rasped by the Periodical Cicadas (*Cicada septemdecim*, Linn, and *C. tredecim*, Riley), otherwise known as Seventeen-year Locusts, by tree-hoppers and a dozen other Homopterous insects; bored into from the side by the Twig-borer (*Bostrichus bicaudatus*, Say), wounded by the bites of such beetles as the New York Weevil (*Ithycerus noveboracensis*, Forster), or pierced as by a red-hot wire by small boring beetles (*Scolytidæ*).

The buds before they expand are infested with the larvæ of the Apple Bud-moth (*Grapholitha oculana*, Harr.), or entirely devoured by voracious cut-worms (*Agrotis scandens*, Riley, etc.). The blossom has no sooner unfolded its delicate and beautiful petals than it is devoured entirely either by the Brazen Blister Beetle (*Lytta ænea*, Say), the Striped Cucumber Beetle (*Diabrotica vittata*, Fabr.), the Rose bug, or by a great many other insects that might be mentioned, some, as the different bees, confining themselves to the pollen or honey from the nectaries, while others again prefer other parts. The young fruit is either eaten partly or entirely by Snapping beetles (*Melanotus communis* and *M. incertus*), or punctured by either the Plum or Apple Curculios, and afterwards bored through and through by their larvæ, or by that ubiquitous Apple Worm (*Carpocapsa pomonella*); as it matures it is eaten into by the larvæ of the Plum Moth † (*Semasia prunivora*, Walsh), rendered putrid by the Apple Maggot (*Trypeta pomonella*, Walsh), and by the Apple Midge (*Molobrus mali*, Fitch); as it ripens it is gouged by the Flower Beetles (*Euryomia inda* and *E. melancholica*), and disfigured by a variety of other insects, while the skin is often gnawed off and corroded by the larvæ of the Rose Leaf-roller (*Loxotænia rosaceana*, Harr.); and even the seed, if it should be preserved, will be attacked by the Grain Sylvanus (*Silvanus surinamensis*, Linn.), the Dwarf Trogosita (*T. nana*, Melsh.) and the larvæ of one or two small moths. And as to the leaves, they are not only sapped and curled by the Apple Plant-louse (*Aphis mali*, Fabr.), and by leaf hoppers; rolled by several leaf-rollers; folded at the edges by a small pale, undescribed worm which I shall soon describe; blistered by the Rosa Hispa (*Uroplata rosa*, Weber);

*I have bred specimens of this insect from apple twigs.

†Inappropriately so called by Mr. Walsh, as I shall presently show.

crumpled by the Leaf Crumpler (*Phycita nebulo*, Walsh), mined by the Apple Micropteryx (*Micropteryx pomivorella*, Pack.); skeletonized and tied together by another undescribed worm, which I shall some day name *Acrobasis Hammondii;* but they are greedily devoured by a whole horde of caterpillars, from the tiny *Micropteryx* to the immense Cecropia worm, some of which confine themselves to the parenchyma, some to the epidermis, some to the tender parts, without touching the veins, while others bodily devour the whole leaf. The sap forms the sole food of some insects, and even when the poor apple tree dies, a host of different insects revel in its dead and decaying parts, and hasten its dissolution, so that it may the more quickly be resolved into the mold from which it had, while living, derived most of its support, and through which it is to give nourishment for the young trees which are to take its place.

Thus we perceive that there is not a single part of the apple tree which is not made to cradle, or to give nourishment to some particular insect, and the same might be said of almost every plant that grows on the face of the earth, even those which produce resinous or gummy substances, or which are pithy in the center, having special insects which feed upon these parts and on nothing else. There are insects—the gall makers, for instance—which, not satisfied with any existing part of the plants, as such, cause abnormal growths, in which their young are reared.

Nor are insects confined to vegetables in their recent state. The block of hickory wood, fifty years after it is made up into wagon wheels, is as palatable to the Banded Borer (*Cerasphorus cinctus*, Drury), which causes "powder-post," as it was to the Painted Borer (*Clytus pictus*, Drury) while green and growing; and a beam of oak, when it has supported the roof of a building for centuries, is as much to the taste of an *Anobium* as the same tree was while growing, to the American Timber Beetle (*Hylecœtus Americanus*, Harr.) Some, to use the words of Spence, "would sooner feast on the herbarium of Brunfelsius, than on the greenest herbs that grow," and others, "to whom

'——— a river and a sea
Are a dish of tea,
And a kingdom bread and butter,'

would prefer the geographical treasures of Saxton or Speed, in spite of their ink and alum, to the freshest rind of the flax plant."

Indeed, it would be difficult to mention a substance, whether animal or vegetable, on which insects do not subsist. They revel and grow fat on such innutritious substances as cork, hair, wool and feathers; and "with powers of stomach which the dyspeptic sufferer may envy, will live luxuriously on horn;" they insinuate themselves into the dead carcasses of their own class; they are at home in the hottest and strongest spices, in the foulest filth, in the most putrid carrion; they can live and thrive upon, or within the living bodies of the larger animals, or of those of their own class; they are at home in the intestial heat of many large animals, reveling in the horse's stomach, in a bath of chyme of 102° Fahr., or in the bowels of man, in an equally high temperature. Some have even been supposed to feed on minerals, and, not to dwell upon Barchewitz's tale of East India ants, which eat iron, certain it is that the larvæ of our May flies (Ephemeræ) do eat earth, and I have known the larvæ of the common May Beetle to feed for three months upon nothing but pure soil; but in both these cases the insects undoubtedly derive nourishment from the vegetable matter which is extracted from the earth by the action of the stomach.

These facts will serve to show that, seek where we may, we cannot find a place or a substance in which or on which, some insect does not feed. They people the atmosphere around us, swim at ease in the water, and penetrate the solid earth beneath our feet; while some of them inhabit indifferently all three of these elements at different epochs of their lives.

Now when we reflect that there are at least half a million—if not a full million—distinct species of insects in this sublunary world of ours, and that their habits and habitations are so diversified, it would really seem as though entomology was a subject too vast for any one man to shoulder; and indeed it is in all conscience extensive enough. The science of entomology is, however, so perfect in itself, and its classification so beautiful and simple that a particular species is referred to its Order, its Family, its Genus, and finally separated from the other species of that genus, with the greatest ease, and with a feeling of true satisfaction and triumph, by those who have mastered the rudiments of the science. And, very fortunately, it is not necessary for the practical fruit-grower to enter into the minutiæ of species or even of genera in order to learn the habits of the insects which interest him in one way or another. These minutiæ must be left to the professed entomologist.

There is not an insect on the face of the globe which cannot be placed in one or the other of seven, or more properly speaking, eight great Orders; so that, unlike the botanist, the entomologist is not bewildered by an innumerable array of these Orders, though he has five times as many species to deal with. These Orders comprise about two hundred families, many of which may, for practical purposes, be grouped into one family—as, for instance, the seven families of Digger-wasps and the five large families which have all the same habits as the true or genuine Ichneumon-flies. Many more may be neglected as small, rare, or unimportant; so that practically there will remain about a hundred family types to be learned. Each family, as Agassiz, has well remarked, may, with a little practice, be distinguished at a glance by its general appearance, just as every child with a little practice, learns to distinguish the family of A's from the family of B's, and these from the family of C's in the alphabet. There is the old English A, the German text A, and a host of ornamental A's, both in the capital letter and the small or "lower-case" letter, as the printers call it; but the family likeness runs through all, and it is astonishing how quick a child learns to distinguish each family type. It is true there are a few abnormal or eccentric insects—there were some which deceived even Linnæus—which put on the habit of strange families, just as an eel, which is a true fish with fins, puts on the habit of a snake—a reptile without fins. But these are the exceptions and not the rule.

Now it is wisely ordained that every family, as a general rule, has not only a distinctive family appearance, but also distinct family manners. For example, nobody ever saw an Ichneumon-fly construct a nest and provision it with insects, as does a Digger-wasp; and nobody ever saw a Digger-wasp deposit its eggs in the body of a living insect at large in the woods as an Ichneumon-fly does. But each family maintains its peculiar family habits, and cannot be induced to deviate from them.

So universally is this the case, that if an insect is brought me which I never saw in my life, I will tell half its history at a glance. It is this "Unity of Habits," this beautiful provision of nature—definite family likeness, accompanied by definite family habits—which so simplifies the task of the practical man; for, instead of having to study the diversified habits of half a million species, he has but to acquaint himself with the appearance and characteristics of one hundred families; and if the rudiments of Entomology had been taught in the schools of this country, so that the farmer had become familiar with these hundred family types, he would now be much better able to cope with his insect enemies. When I think that it would take a child no longer to learn these one hundred family types than it does to learn the one hundred different types which compose the four alphabets—the Roman capital and small alphabet and the writing capital and small alphabet—I fully expect, and sincerely hope, that in the public schools of this country we shall soon have text-books introduced which will cover the ground as well, and occupy the same place as do those useful works of Leunis, and Troschel and Ruthe, in the public schools of Germany.

With these few remarks, which are intended to show that the practical man may easily obtain a general knowledge of his insect friends and enemies, notwithstanding the wide field of their operations and the immense number of species which exist, we will now dwell for a while on one of these families, which deeply interest us as fruit-growers, namely:

THE CURCULIONIDÆ OR SNOUT-BEETLES.

This is one of the very largest and most conspicuous families in the Order of Beetles (*Coleoptera*), comprising, as it does, over 10,000 distinct and described species. It is at once distinguished from all the other families of beetles by the front of the head being produced into a more or less elongated snout or rostrum, at the extremity of which the mouth is situated. This snout is sometimes very long and as fine as a hair (genus *Balaninus*), and sometimes as broad as the head (genus *Brenthus*); but it always forms part and parcel of the head, and does not articulate on it as does the snout or proboscis of the true Bugs (*Hemiptera*), or the tongue of Moths and Butterflies. The other chief characteristics of the family are an apparently four jointed tarsus or foot (though in reality there are more generally five joints), an ovoid form narrowing in front, the sides pressed by the convex elytra or wing-covers, the antennæ or feelers attached to the snout, and either elbowed or straight, and composed of nine, ten, eleven or twelve joints—the first of which is always long, and the terminal three generally united in a club or knob; and finally stout legs with swollen thighs, sometimes bearing spines.

The larvæ of these snout-beetles are whitish or yellowish and fleshy grubs, usually without legs or having only in the place of them fleshy tubercles, which in a measure perform the functions of legs;* the body is oblong, with the back generally arched but sometimes straight. With these characteristics in mind, the farmer cannot fail to recognize a snout-beetle when he sees one. Now there is hardly one of the one hundred families that I have referred to from which so many injurious species can be enumerated, for with the exception of an European species (*Anthribus varius*) whose larva was found by Ratzeburg to destroy bark-lice, they are all vegetarians, the larvæ inhabiting either the roots, stems, leaves or fruits of plants; and the beetles feeding on the same. So whenever you find an insect with the characters just given, you may rest morally certain that it is injurious, and should be destroyed without mercy. This family is not only one of the most injurious, but, on account of the secretive habits of the larvæ, the insects comprising it are the most difficult to control. When a worm is openly and above board denuding our trees, we at least readily become aware of the fact, and can, if we choose, apply the remedy; but when it surreptitiously, and always under cover, gnaws away at the heart of our grains and fruits, we become in a measure helpless to defend ourselves. But even here where the enemy is so well ambushed and hidden, the proper tactics, based on thorough knowledge, will frequently enable us to penetrate the defenses and conquer the foe.

Before leaving this subject of families, let me impress upon the mind another important fact, namely, that the family is not peculiar to any one country, and that while species vary, the family has the same habits and characteristics all over the world. Thus in Europe

*It is generally unqualifiedly stated by authors that Curculionid larvæ are apodous; but there are exceptions to the rule, and I may cite as an example the larva of *Cratoparis lunatus*, Fabr., which I have found in fungi, and have bred to the perfect state, and which has six conspicuous thoracic legs.

we find the snout-beetles as injurious, and as difficult to manage—if not more so—than they are in this country. One species (*Rhynchites conicus*, Herbst.,) deposits eggs in the twigs of Pear, Plum, Cherry and Apricot, and girdles the twig to make it fall; another, (*Rhynchites bacchus*, Schœn.) infests the fruit, and still another (*Anthonomus pyri*, Schœn.) the flower bud of the Pear. One, (*Rhynchites betuleti*, F.,) rolls up grape leaves and partly cuts the stems, so that they perish, while another, (*Anthonomus pomorum*, Schœn.,) infests the blossom bud of the Apple, and renders it unfertile. Still another inhabits the blossom bud of the Cherry. *Balaninus nucum* is found in their common Hazel-nut, and *B. cerasorum* in Cherry pits; *Apion apricans* devours the seed of Clover; *Otiorhynchus sulcatus*, Schœn., infests the crown of strawberries and two different species (*Baris chlorizans*, Schœn., and *Ceutorhynchus napi*, Schœn.,) infest the stems of cabbages and turnips.

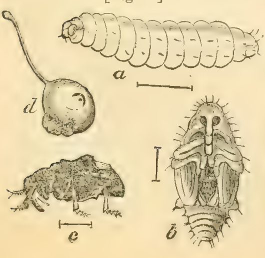
But after all, a single species—the "little Turk," for instance—sometimes causes more loss of fruit in this country than all the above enumerated species do to the European cultivator, and though much of this comparative incapacity for harm, on the part of their insects, may be in a measure due to the better knowledge of his foes which the transatlantic cultivator possesses; to the more careful culture which he pursues, and the usually limited extent of his orchard, compared with ours; yet it greatly depends on other causes, which it is not necessary now to dwell upon. So I will at once proceed to say a few words about those of our own Snout-beetles, which more particularly interest us.

THE COMMON PLUM CURCULIO—*Conotrachelus nenuphar*, Herbst.

IT IS SINGLE BROODED, AND HIBERNATES AS A BEETLE.

I shall not here repeat what has already been published about this insect; but shall confine my remarks principally to the unsettled and mooted points in its natural history, and to the new discoveries that have been made since the appearance of my first Report. I am glad to be able to say that I have forever settled the principal question, namely, as to its being single or double brooded. Authors have, from the beginning, held different views on this subject, and this fact should not surprise us, when we bear in mind that

[Fig. 1.]



they reasoned simply from conjecture; nor will it surprise us when we understand the facts in the case. The facts that fresh and soft Curculios are found in this latitude as early as the last of June, and that they still come out of the ground in August, or as late as September, and even October in more northerly latitudes, are well calculated to mislead; while it was difficult to imagine an insect living ten months before ovipositing, without dwindling away through the action of its enemies. But in the beetle state, the Curculio has few, if any enemies, and in my former writings on this subject, I have shown that the other facts do not in the least prove the insect to be double-brooded. Among those whose opinions commanded respect, from their profound entomological knowledge and general accuracy, was Mr. Walsh, who, during his last years, strenuously contended that this insect was double-brooded. For several years I have entertained a different opinion, believing that it was single brooded, as a rule, and only exceptionally double-brooded; and the facts so fully bear me out in this opinion, that were my late associate living to-day, I should bring forth the testimony with a feeling of triumph, for he was not often in the wrong! It is worthy of remark, however, that Mr. Walsh's first impression, as given by him in the year 1867*, was that this insect is single brooded; his first opinion thus coinciding with what I have now proved to be the facts in the case. In my first Report I have reviewed the experiments which led him to change his opinion, and have shown that they did not warrant his final conclusion.

The many words that have been penned in the discussion of this question would fill a volume; but one stern fact, one thorough experiment, is worth more than all the theories that were ever conceived, or the phrases that were ever written on the subject. At first it seems to be a very simple question to settle, but the fact that it remained unsettled so long would indicate the reverse. Judge A. M. Brown of Villa Ridge, at my suggestion, endeavored in the summer of 1869 to solve the problem by imprisoning the first bred beetles and furnishing them with plucked fruit. Dr. Hull partially performed a like experiment, and I did the same myself; but we were met by the advocates of the two-brooded theory with the objection that such a test was of no value, as the Curculio would not deposit on plucked fruit or in confinement; and to add weight to their argument they could cite us to numerous instances among butterflies to prove that many insects really will not deposit in confinement. But, as we shall see, they placed too much confidence in the instinct of Mrs. Turk when, from such premises, they made these deductions apply to her.

As I proved over and over again, the question could not be solved with any more certainty, by confining beetles to living boughs containing fruit, as the boughs could not well be covered with any sub-

* Practical Entomologist, Vol. II., No. 7.

stance through which the beetles would not gnaw their way out. So I determined last spring to build a frame over a large tree and entirely enclose it in stout gauze, that would neither let a flea in or out, much less a Curculio. Having accomplished this before the blossoms had fallen off the tree, I awaited with pleasurable interest the result from day to day, from week to week, and from month to month; engaging a competent person to watch, when, from necessity, I was obliged to be away. It were worse than waste of time to detail here the many interesting observations made on this tree which I had under control, or to enumerate the many other experiments which I conducted in other ways, or the innumerable facts obtained; and it will suffice to give in a summary manner the results—premising only that every precaution was taken, and no expense spared, to prevent failure; that the experiments were satisfactory beyond my expectations, the results conclusive beyond all peradventure, and that I can prove every statement I make. To sum up then:—*The Plum Curculio is single-brooded*, and I have a number now alive *which were bred during the latter part of June from the first stung peaches.* (At the time the printer is ready for this Report the beetles are still alive and flourishing—February 24th, 1871.) But, as there seem to be exceptions to all rules, so there are to this; yet the exceptions are only just about sufficient to prove the rule, for as far south as St. Louis not more than one per cent. of the beetles lay any eggs at all, until they have lived through one winter; or in other words, where one female will pair and deposit a few eggs the same summer she was bred, ninety-nine will live on for nearly ten months and not deposit till the following spring. In more northern latitudes I doubt if any exceptions to the rule will be found.

As to the other mooted point, namely, whether this insect ever hibernates under ground in the larva state, I am perfectly satisfied that it never does, but that it passes the winter invariably as a beetle, under all sorts of shelter in the woods; generally, however, near the surface of the ground. Indeed, it often makes for itself a hole in the ground, seldom however deep enough to more than barely cover its own body. In short, there is very little to alter or modify in the established facts in its natural history, which I have already published. The egg, instead of being "oval," as there stated, would be better described as "oblong-oval," measuring exactly 0.03 inch in length, and being nearly three times as long as wide. It should also be remarked here, that when depositing the eggs in apples, the female often neglects the usual symbol of Mohammedanism, which she so invariably inscribes upon stone fruit; and that where this mark is made on apples, it more easily becomes obliterated.

During their beetle life, these insects feed continually, just as long as the weather is mild enough to make them active. While fruit lasts, they gouge holes in it, and after peaches have gone, apples are badly attacked. They also gnaw large holes in the leaves, and when nothing else presents, will feed on the bark of the tender twigs.

The beetles often make a peculiar creaking noise (a fact not mentioned before of this species) by rubbing the tip of the abdomen up and down against the wing-covers.*

Let us be thankful, therefore, that there can no longer reasonably be difference of opinion, or discussion on these questions, which, though of no very great practical importance, were yet of great interest to us all.

IT IS NOCTUNRAL RATHER THAN DIURNAL.

Before leaving this little Turk, however, I have some other facts to mention which were first brought to light the present year, and which have a most important practical bearing. The people of the West have been repeatedly told, and with so much assurance that they no doubt have all come to believe it as gospel, that Curculios fly only during the heat of the day, and that it is useless to endeavor to catch them after say 10 o'clock in the morning. What I am about to utter will no doubt astonish many, but I know whereof I speak. *The Curculio is a nocturnal rather than a diurnal insect; is far more active at night than at day, and flies readily at night into the bargain.* If any one doubts this assertion, let him go into his peach or plum orchard at midnight with a lantern and sheet, and he will catch more than he could during the day, and will also find, to his sorrow, that they are then much more nimble and much bolder—

*A great many different beetles belonging to widely different families have the power of making a stridulating creaking noise, and though the instrument is found upon different parts of the body in different species, yet it is always made after one plan, namely, a file-like rasp and a scraper. In Darwin's new book (Descent of Man, pp. 366–73) an interesting account of the different methods employed will be found. Every entomologist knows how commonly this creaking noise occurs in the Long-horn beetles, and that the rasp is situated on the mesothorax and is rubbed against the prothorax. In the Burying beetles (NECROPHORIDÆ) these rasps are situated on the fifth abdominal joint, and are scraped by the posterior margin of the elytra. In the Dung-beetles again it is variously situated upon different portions of the body. Dr. Fitch (10th Ann. Rep. p. 12) has noticed the creaking noise made by the Three-lined Leaf-beetle (*Lema trilineata*) which is produced by the same motions as those witnessed in our Curculio; but in this instance, as in all other stridulating Chrysomelidæ, the rasp is situated on the dorsal apex of the abdomen known as the pygidium, and is scraped by the wing-covers; while in the closely allied Curculionidæ which have this power the parts are completely reversed in position. Any one who will take the trouble to carefully examine the wing-covers of our Plum Curculio will find on the lower apical edge of each, a horny, slightly raised plate, about a third as long as the whole wing-cover, and transversely and obliquely ribbed by numerous parallel ridges. There is also a longer cord or carina near the sutural edge which may help to intensify the noise. The dorsal apex of the abdomen or pygidium forms a yellowish and roughened plate, with the sides horny and emarginate, so that when the abdomen plays up and down, these horny edges grate or scrape at right angles against the rasp.

In some instances the stridulation is possessed principally by one sex and serves no doubt as a sexual call; but with our Curculio as with most other stridulating beetles, both sexes seem to share alike in the power, and it then no doubt serves as a mutual call, or is used under the influence of distress, fear, or even pleasure; for I have always more particularly noticed the noise of an evening when the Curculios were most active and preparing for their active night work.

scarcely feigning death at all. Indeed, with the exception of such females as are busily occupied in depositing eggs, most of the Curculios rest during the day, sheltered either by the foliage or branches of the tree, or by any extraneous substance on the ground near by. They are also more active in the evening than in the morning, and these facts lead us to the important question, whether the morning or the evening is the best time to jar the trees. My experiments so far are not conclusive, for I have some days caught more in the morning, and at others more in the evening. All other things being equal, the evening will prove preferable to the morning, from there being less dew at that time; and I particularly draw attention to this matter now, that the proper experiments may be instituted during the coming year by more than one individual.

THE RANSOM CHIP-TRAP PROCESS.

Another grand and successful mode of fighting the little Turk was also brought to light again, and to a great extent practiced the past summer. I allude to the Ransom chip process for entrapping this insect. About the middle of May the Horticultural world was startled by a somewhat sensational article, which was the burden of an extra to the St. Joseph (Michigan) *Herald*, headed:—"Great Discovery—Curculio Extermination Possible." The process consists in laying close around the butt of the tree pieces of chips or bark, under which, according to their instinct, a great many of the Curculios secrete themselves during the day, and may thus be easily destroyed. Now that we better understand this insect's habits, we also better comprehend the philosophy of this process. Being noctural in their habits, the beetles naturally seek shelter during the day, and especially is this the case early in the season, when the days are chilly, and before the females are too much engaged in egg depositing. Numerous opinions were expressed as to the value and efficiency of this method; but I will here repeat my own, as given to the readers of the *American Entomologist and Botanist;* first, because I endeavored to be candid and truthful, and secondly, because the opinions expressed have been so far fully corroborated by subsequent experience. Let it be distinctly understood that in recording what I believe to be the facts in the case, I have no wish to detract one particle from the credit due Mr. Ransom, for bringing this method prominently before the people, and demonstrating its practical applicability; for to him undoubtedly belongs the honor of the re-discovery and of the proper application of the method:

"We are really sorry to damp the ardor and enthusiasm of any person or persons, when enlisted in such a good cause, but truth obliges us to do so, nevertheless. Of course Curculio extermination is possible! but not by the above method alone, as our Michigan friends will find to their sorrow. For a short time, early in the season, when the days are sometimes warm and the nights cold, and before the peach blossoms have withered away, we have succeeded in capturing Curculios under chips of wood and in other such sheltered situations; but we have never been able to do so after the fruit was as large as a hazlenut, and the little Turk had got fairly to work. Our Michigan friends will, we fear, find this to be too truly the case.

"This process, furthermore, cannot well be called a new discovery, because it was discovered several years ago, as the following item from Moore's *Rural New Yorker* of January 28th, 1865, will show:

"HOW TO CATCH CURCULIO.—In May last we had occasion to use some lumber. It was laid down in the vicinity of the plum yard, and on taking up a piece of it one cold morning, we discovered a number of curculios huddled together on the under side. On examining other boards we found more, so we spread it out to see if we could catch more, and we continued to find more or less every day, for two weeks. We caught in all one hundred and sixty-one. So I think if people would take a little pains they might destroy a great many such pests. These were caught before the plum trees were in flower. What is most singular is, that we never found a curculio on a piece of old lumber, although we put several pieces down to try them. They seemed to come out of the ground, as we could find them several times a day by turning over the boards.

Johnsonville, New York. MRS. H. WIER.

"But though Mr. RANSOM cannot properly claim to have made a new discovery, and although this mode of fighting will not prove sufficient to *exterminate* the Curculio, yet we greatly admire the earnestness and perseverance which he has exhibited. In demonstrating that so great a number of the little pests can be entrapped in the manner described, Mr. R. has laid the fruit growers of the country under lasting obligations to him. It is a grand movement towards the defeat of the foe, and one which, from its simplicity, should be universally adopted early in the season. But we must not relinquish the other methods of jarring during the summer, and of destroying the fallen fruit; for we repeat that the Plum Curculio will breed in the forest."

I subsequently visited St. Joseph, for the express purpose of examining more closely into Mr. Ransom's Curculio remedy. I found that so few Curculios had been caught under the chips after the first week in June, that nearly everybody, except Mr. Ransom, had for some time abandoned the method, and were jarring their trees by one process or another. Mr. Ransom himself, by dint of unusual perseverance and great care in setting his traps, had much better success than I had expected he would. On the 15th June he caught 78; on the 16th, 97; and on the 17th, 71. For about a week after this he scarcely caught any, but from the 24th to the 27th inclusive, he caught about 300. On the 6th of July I accompanied him around the outside rows of his orchard and caught five under the traps. We had no opportunity to use the sheet, but I am satisfied that more could have been jarred down. Mr. R. had a very fair crop of peaches, and—forgetting that crops have often been grown before with very little care, and that others around him who did not bug so persistently had fruit also this year—is very sanguine of his new method, and too much inclined, perhaps, to attribute his crop solely to this remedy. Nevertheless, contrary to the impression made by his published views, he was candid enough to admit that it might be found necessary to resort to the jarring process, after a certain season of the year; and indeed the number of stung peaches on the ground showed too plainly that there is no hope of *extermination* by the chip plan alone. The soil around St. Joseph is, for the most part, a light sandy loam, never packing, and very easily kept in good cultivation. To this character of the soil must be attributed much of the success with the Ransom method; for I am satisfied, after full experiment, that in the warmer climate and heavier soil of St. Louis, it is of no practical use after the middle of May, or at the farthest, after the first of June. The few specimens that I have captured by this method at St. Louis were found under small pieces of new shingle; and Mr. W. T. Durry, who has 2,300 trees in his orchard at St. Joseph, also found this the best kind of trap. Mr. Ransom, however, prefers small pieces of oak bark, which he places close around the tree, with the inner or concave side pressed to the ground. Stones do not answer well, and corn cobs are objectionable because it requires so much time to discover and destroy the Curculios, which hide in their deep cavities.

The best time of day to take the Curculios from under the chips is undoubtedly in the afternoon; but it must not be left too long, as they begin to leave and scatter over the trees as soon as the sun approaches the horizon. The chips should be laid around the trees as soon as the frost is out of the ground, or at least by the time the blossoms begin to expand; for more beetles will be caught under them during a few weeks thus early in the season than throughout the rest of the year.

Before concluding this branch of the subject, I earnestly urge upon fruit-growers throughout the State to give this process a good trial during the coming season, and to report the results to me. The observations of a hundred persons in as many different parts of the State must necessarily be of more value than those of a single individual in any one locality; and as the process was not prominently brought before the public last year, until it was too late to make thorough experiments, it is very desirable to have the true value of the method in Missouri definitely ascertained in 1871. To arrive at such definite knowledge of its value, I need the co-operation of intelligent fruit-growers, and for this reason I hope that notes and experiments will be made and sent to me at my office, any time during the summer. The number of trees experimented on, number of beetles captured, time of year, hour of day, character of soil, and all other facts connected with the experiments should be noted; as they all help us to a more thorough knowledge of the true value of the process

KEEPING IT IN CHECK BY THE OFFER OF PREMIUMS.

After visiting St. Joseph and vicinity, I passed into Ontario, where I found the trees overloaded with fine unblemished fruit. I found my friend, Mr. Wm. Saunders, of London, also much occupied with, and interested in, the Curculio question. He was, in fact, carefully counting different lots of this insect which had been received from different parts of the Dominion; for be it known, that the enterprising Fruit-Growers' Association of Ontario, in its praiseworthy efforts to check the increase of the Curculio, offered *a cent per head* for every one which should be sent to our friend, who happens to be secretary of that body. What would our own people think if the Legislature or the State Horticultural Society should offer an equally liberal premium *per capita* for every little Turk captured? Wouldn't they set about capturing them in earnest, though! The Legislature might stand it, and I am not sure but that some such inducement, held out by the State to its fruit-growing citizens, would pay, and prove the most effective way of subduing the enemy. But the Horticultural Society that should undertake it, would have to be pretty liberally endowed. Just think of it; ye who catch from three to five thousand per day. The bugs would pay a good deal better than the peaches. However, very fortunately for the Ontario Fruit-Growers' Association, their good offer did not get noised abroad as much as it might have been, and the little Turk occurs there in such comparatively small numbers, that up to the time I left only 10,731 had been received.

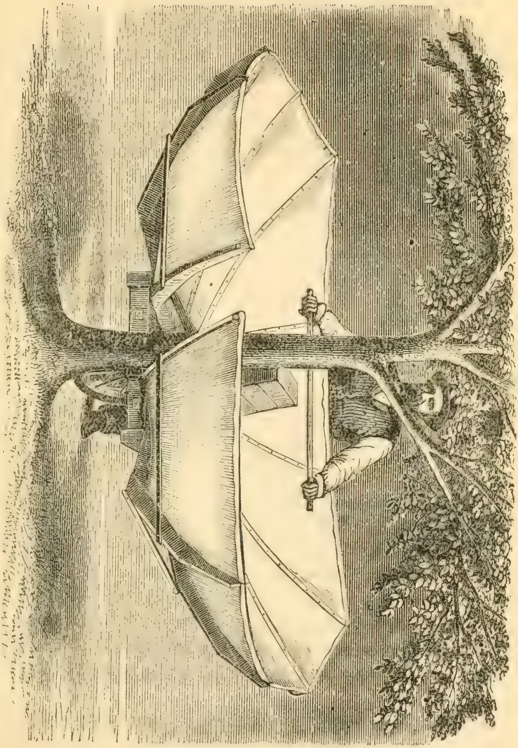
PARIS GREEN AS A REMEDY.

Mr. G. M. Smith, of Berlin, Wisconsin, in an article written last fall to the St. Joseph (Mich.) Horticultural Society, recommends Paris Green for the Plum Curculio. Even if the uniform application of such a poisonous drug on large trees were practicable, it would never succeed in killing one Curculio in a hundred. Paris Green kills the leaf-eating beetles by being taken internally with the leaves; but the Curculio, with its snout, prefers to gouge under the skin of the fruit, and only exceptionally devours the leaves. Yet, notwithstanding the palpable absurdity of the remedy, it has very generally passed from one journal to another without comment.

JARRING BY MACHINERY.

Of course there is no more expeditious way of jarring down the Curculio than by the Hull Curculio-catcher (Fig. 2.) Yet I confess that after extensive observations in many different parts of the country I am forced to the conclusion that this machine does not give the satisfaction one could wish. I have already shown that where it was constantly used the trees suffered serious injury from bruising, and it is a rather significant fact that in most orchards where it has been introduced, some modification has soon followed, or else it has been entirely abandoned; while in the East they still adhere to the improved stretchers and mallet. It seems to me that the machine, as made by Dr. Hull, two years ago, was not only too heavy and unwieldy, but incapable of giving the requisite sharp jarring rap to the branches of a large tree without causing too much injury to the trunk; and that if a modification of it could be made to satisfy the peach-grower, there would soon be a greater demand for such a machine.

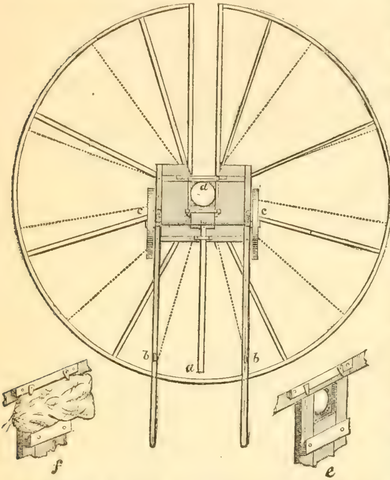
[Fig. 2.]



[A full description of this machine, without any figure, was given in my first Report, pp. 60-61.]

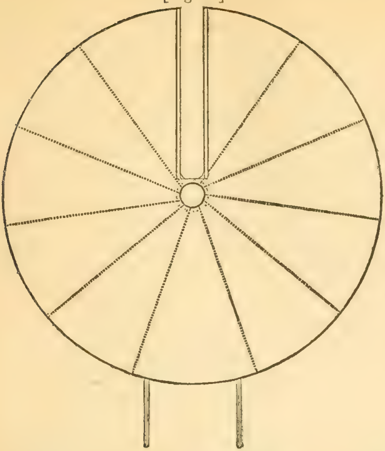
As a step in the right direction I will briefly describe a machine which I have herewith illustrated, (Fig. 3, back view; Fig. 4, front view), and which I found in quite general use around St. Joseph and Benton Harbor, Michigan. It was gotten up by Mr. L. M. Ward of the latter place, and proves, in the orchard, to have decided advantages over the Hull machine, of which it is a modification. It is a much lighter machine, and, as the diagrams indicate, instead of running on a single wheel it is carried and balanced by two, (Fig. 3, *c c*) and supported with legs on the handles, (Fig. 3, *b b*), when not running. The Curculios and stung fruit are brushed through a hole in the centre (Fig. 3, *d*), and as the operator passes from one tree to another he closes this hole, to prevent the beetles from escaping, by means of a slide, (Fig. 3, *a*), which he has under control. Bags previously prepared, by being fastened on a square piece of wood with a hole in the centre corresponding to a hole in the side of the bag, are snugly buttoned below (Fig. 3, *e* and *f*), so as to secure everything that falls through from above, and when one bag is full it is easily replaced by another, and its contents destroyed by scalding, or otherwise, and emptied out. In most of the orchards where this machine was being used, the jarring was performed by a separate mallet, which is easily hung, as is also the brush, on the shafts when the machine is being operated by one person, or, which I think a better way, where help is not scarce, it can, with the brush, be carried by a second person (an intelligent boy will answer,) who performs the jarring and brushing while the first person wheels the machine.

[Fig. 3.]



The machine is simple in construction, and any one with ordinary mechanical ability can build it—modifying, of course, the diameter of the wheels and the inclination of the sheet to suit the character of his trees or of his ground. Mr. Ward has taken no patent out for it, and the machine is, therefore, public property. The platform may be made narrower than shown in the illustration, for the nearer the wheels approach and the lighter the machine, the better. It has been argued in favor of the one-wheel machine, that it can be more easily

[Fig. 4.]



run on rough ground and more readily turned, which, in a great measure, is true; but the Ward machine might be so made that it could easily be tilted on one wheel in turning, and our Benton Harbor friends have so far found no difficulty in operating it. The two wheels have the additional advantage that the machine is not rendered unwieldy by strong wind. It also stands firm when left by the operator, who is thereby better enabled to use a mallet if he prefers it, the mallet being hung to the shafts, and taken down after the machine is wheeled into position. Either machine can be used with a bumper, or with a mallet, and there are certain rules which should be adopted in jarring for the Curculio, no matter whether a one-wheel or a two-wheel machine is used. These rules are: First. In jarring with a mallet, it is best to prepare each tree by squarely sawing off some particular limb, or else the mallet must be well protected with rubber to prevent bruising of the tender bark. The former custom is by far the best, as we are enabled to give the tree a sharp, vibrating rap with the bare, hard wood. Secondly. If the mallet is dispensed with, and the tree is bumped with the machine—a method which certainly has the advantage of expedition—it will be found altogether more profitable to drive a shouldered spike or to insert a shouldered screw in the trunk at the right distance from the ground, and the jarring can then always be done on this spike without injury to the tree.

If the trees are headed high enough to admit of a sufficient inclination of the canvas, the beetles will naturally roll to the centre and fall into whatever receptacle there may be for them below; but such an inclination is not often practicable, and the brush or broom is almost always needed.

The orchardist must also be guided in his choice of machines by the character of his land, for the two-wheel machine doubtless owes much of its success around St. Joseph, Michigan, to the smoothness of their land. No machine will work well on rough, cloddy soil.

There are various improvements that might be made in the above machine by any ingenious person, and at my suggestion Mr. J. E. Porter of the Eagle Agricultural Works, Ottawa, Illinois, has commenced building these two-wheel machines with adjustable arms. The canvas also is to be so made that it can be fastened on and taken off again so that the whole may be more compactly packed for shipping, and for storing away out of the wet. Exclusive of the canvas, the whole can be made ready for shipment for from $16,00 to $18,00, and the machine will no doubt be advertised the coming season.

It is gratifying to know also that the inventive genius of some of our Western men is being applied to the improvement of this implement. Thus Messrs. Claxton & Stevens of the Insane Asylum, St. Louis county, have just applied for a patent on a one-wheel machine, the principle feature of which is a bumper which works with a spring.

[Fig. 5.]

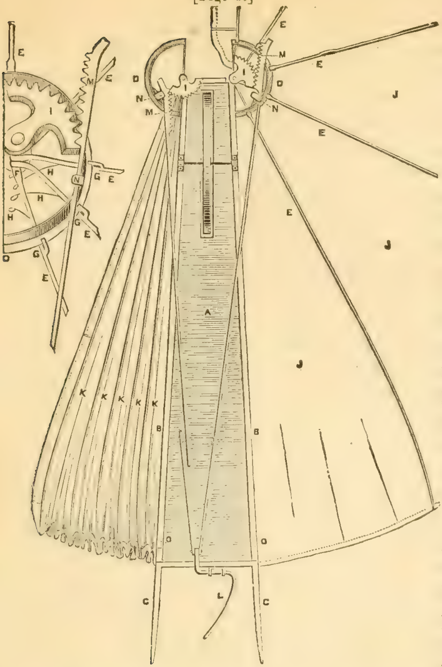
I have seen the model, but am not favorably impressed with the machine as one having any great practical value. The spring bumper is an expensive and unnecessary addition, and in other respects the machine is inferior in utility to that I have just described. One good feature, however, is an arrangement for closing up the tree-way where the bumper touches the tree. It consists simply of two long strips of sheeting fastened to a light frame, each one of which is so attached to the sides of the tree-way that when dropped they form a roof as at Figure 5. The tree easily separates these two pieces when the machine is worked. The frame of this machine is quite flat with an upturned rim, but each half-circle is so arranged that it can be raised on hinges.

Dr. M. M. Hooten, of Centralia, Illinois, patented last summer a machine made very much after Dr. Hull's plan, but he has since made several improvements and changes and has made application for another patent for the improved machine which I herewith illustrate from a model with which he has kindly furnished me.

He first constructs a long narrow wheel-barrow with a level and smooth platform (Fig. 6, *a*,) made of ½ inch pine or other light material, firmly nailed down to two arms (*b*, *b*,) and covering them from the front end to within twenty inches of the rear end. These rear ends serve for handles (*c*, *c*). The anterior ends, at a point one foot from the extremity, rest upon the axles of the wheel, which is two feet in diameter. He then attaches a half circle (*d*, *d*) to each outer side of the forward ends of the arms of the platform. These half circles are ten inches in diameter, and are so placed as to be about two-thirds of their width in advance of the platform, which at the forward end is from ten to twelve inches wide. Thus enough room is left for the tree to be admitted between the flat sides of the half circles.

There are now to be five or six movable arms (*e*, *e*) placed on each side of these iron half circles, and a single half-inch bolt (*f*) passed through a hole in the inner ends of them, and through the straight bar next to the tree-way. The arms are now permitted to rest on the half circles, and are held down to the circle by a hook

[Fig. 6.]



which is attached to the lower side of the arm and curves over the outside of, and under, the circle (g, g).

These movable arms are now arranged at equal distances on the circles, and fastened with twine, while the canvas is being tacked on, beginning first by tacking it to the sides of the platform of the barrow and then to the arms. At the inner end of each of these movable arms is a raised finger (h, h), which holds the canvas up so as to keep any insects from being thrown over into the tree-way. A semi-circular cog-wheel (i, i), which works by its centre, is now placed on the lower end of the same bolt that passes through the inner ends of the movable arms. The forward arm on each side is firmly attached to this cog-wheel, which works under the canvas. When made to revolve backwards or forwards on the bolt, this cog-wheel carries the outside arm around on the iron half circle, and the sheet-covered frame is thus easily stretched and opened, as at j, j, or closed as at k, k.

This motion is quickly accomplished by means of a lever (l), which works on a hinge at the rear of the platform, and which moves a rod armed on one side at the forward end with cogs (m, m), which tread in the cogs of the semi-circular cog-wheel before described, to which it is held by a keeper (n). The handle of the lever lies on the platform when the machine is folded, and stands upright when it is extended; so that by a single motion of one hand of the operator, the machine may be folded into a very small compass, or as quickly extended. The hinder part of the machine is supported by two swinging legs (o, o). These may swing back to the handles, but cannot go forward beyond a right angle. The machine is very light, and works so easily that, according to the inventor, a boy of fourteen years can easily run one of them. The whole machine does not weigh over forty pounds.

The above figure represents a back view of the machine, with one side open and the other closed. The principle advantage of the machine lies in this folding apparatus, which enables the operator to defy the wind which on some days renders the original Hull machine almost useless as it plays powerfully against the stretched canvas. This feature also enables the owner to store the machine away with less trouble. I have my doubts, however, whether the advantage gained sufficiently compensates for the extra machinery. Another advantage which Mr. Hooton claims for the machine is that it is so low that it will swing its broad folds under low-headed trees. That portion of the wheel which rises above the platform is protected by a circular box, and it is found that every time the canvass is expanded, there is a slight jerk, which casts everything that has fallen upon it to the centre, where the bugs and fruit consequently remain until removed. The raised fingers to which the canvas is attached at the centre, and similarly raised pieces along each side of the tree-way, prevent the insects and fallen fruit from escaping; and there is no receptacle below into which they can be brushed. The machine is therefore built with the idea that it is as easy to pick up and remove the fallen beetles and fruit as it is to brush them into a receptacle below.

In operating the machine it is wheeled up to the tree while closed, then expanded and drawn back a little so as to give the tree a jar, and then closed and wheeled away to the next tree. Mr. Hooton has had a full sized machine in operation, and it seems to give very good satisfaction. As there is considerable casting needed, the ordinary fruit-grower will not be able to manufacture it as easily as he can the Ward machine; but as all these machines will doubtless be put upon the market the coming season, the reader must choose for himself which he prefers.

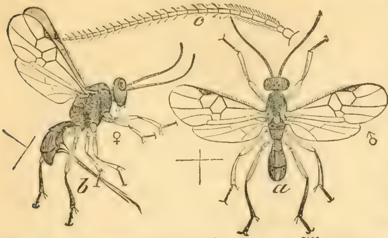
I have been urged to take an interest in two of these machines, and even to take out a patent for certain improvements suggested; but as a public officer I have refused to do either. My object is to give a disinterested and candid account of what I conceive to be the merits or demerits of any machine that may appear, in the hope that ere long we shall have something in the market, so cheap and efficient that no peach-grower will have any excuse for not jarring his trees.

TWO TRUE PARASITES OF THE PLUM CURCULIO.

THE SIGALPHUS CURCULIO PARASITE.

Just 10 years ago, in his "Address on the Curculio," delivered at the annual meeting of the N. Y. State Agricultural Society, Dr. Fitch gave an account, accompanied with a figure, of a small Ichneumon-fly which he named *Sigalphus curculionis*, and which he believed was

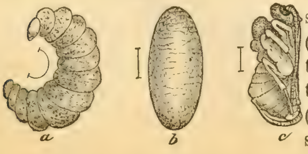
[Fig. 7.]



parasitic on the Curculio. Before that time no parasite had ever been known to attack this pestilent little weevil, and even up to the present time it is currently believed that no such parasite exists; for unfortunately the evidence given by Dr. Fitch was not sufficient to satisfy some of our most eminent entomologists. These parasites were in fact received by him from Mr. D. W. Beadle of St. Catherines, C. W., who had bred them from Black-knot, from which he bred at the same time a certain number of Curculios; but as other worms besides those of the Curculio are likewise found in Black-knot, we had no absolute proof that this fly was parasitic on the insect in question. Consequently we find that Mr. Walsh, in his Report as Acting State Entomologist of Illinois, rather ridicules the idea of its being a Curculio parasite and endeavors to prove that it is parasitic instead on the larva of his Plum Moth (*Semasia prunivora*). But I have this year not only proved that poor Walsh was himself wrong in this particular inference, but that he was equally wrong in supposing his little Plum-moth, so called, to be confined to plums; for I have bred it from Galls (*Quercus frondosa*, Bassett); from haws, from crab apples and abundantly from tame apples.

To be brief, Dr. Fitch's *Sigalphus* is a true parasite on the Plum Curculio and I have bred hundreds of the flies from Curculio larvæ. The first bred specimens gave me much pleasure, for as soon as I saw they belonged to the same genus as Dr. Fitch's fly, I felt assured that another disputed question was settled. But to make assurance doubly sure, I repeatedly half filled large jars with pure earth, finely sifted so that no living animal remained in it. Into these jars I placed Curculio larvæ from day to day as they issued from peaches that were thrown into another vessel, and in due time the parasitic flies began to issue from the ground along with the perfect Curculios. Nay more than this, I soon learned to distinguish such Curculio larvæ as were parasitised, and after they had worried themselves under the ground—seldom more than half an inch—I would uncover them, and on several occasions had the satisfaction of watching the gnawing worm within reduce its victim until finely nothing was left of him.

[Fig. 8.]



As soon as the Curculio larva is destroyed by the parasite, the latter (Fig. 8, *a*) encloses itself in a tough little yellowish cocoon of silk (Fig. 8, *b*), then gradually assumes the pupa state (Fig. 8, *c*) and at the end of about the same length of time that the Curculio requires to undergo *its* transformations and issue as a beetle, this, its deadly foe, gnaws a hole through its cocoon and issues to the light of day as a black four-winged fly (Fig. 7, *a male; b female*). In the vicinity of St. Louis, this fly was so common the past season that after very careful estimates, I am satisfied three-fourths of all the more early developed Curculio larvæ were destroyed by it. On the 17th and 18th of April, in that locality a severe frost killed the peach buds on all but a few of the young and most vigorous trees of Hale's Early and Crawford, so that instead of a large and abundant crop of peaches to depredate on, the little Turk had to concentrate its attacks on the few peaches that were left; and no one expected that any fruit would be saved. Yet the work of this little parasite was so effectual that, wherever fruit set, a fair crop was gathered even by those who made no effort at all to protect their trees!

While visiting Dr. Fitch last August, at his house in Salem, N. Y., I compared my bred specimens with his species, and found them identically the same; but a full description of it will be found below, and it is not necessary at present to dwell upon its characters.

As Mr. Walsh bred this same parasite from the larvæ of his little Plum Moth, it doubtless attacks other soft-bodied larvæ and does not confine itself to the Plum Curculio. This is the more likely as it would scarcely pass the winter in the fly state. The female, with that wonderful instinct which is exhibited in such a surpassing degree in the insect world, knows as well as we great Lords of Creation what the little crescent mark upon a peach or plum indicates; and can doubtless tell with more surity, though she never received a lesson from her parents, whether or not a Curculo larva is drilling its way through the fruit. When she has once ascertained the presence of such a larva by aid of her antennæ—which she deftly applies to different parts of the fruit, and which doubtless possess some occult and delicate sense of perception, which, with our comparatively dull senses, we are unable to comprehend—then she pierces the fruit, and with unerring precision, deposits a single egg in her victim, by means of her ovipositor.

Now there is, as I shall show in the description, a variety (*rufus*) of this parasite, with the ovipositor nearly one-fifth of an inch long, but in the normal form the ovipositor is only twelve-hundredths of an inch long, and the Curculio larva must therefore be reached soon after it hatches, or while yet very young. Consequently we find that the earliest Curculio larvæ, or those which hatch while the fruit is yet small, are the most subject to be parasitised, and while from larva obtained early in the season, I bred more parasites than Curculios, this order of things was reversed a little later in the year. Some persons will no doubt wonder how such a large fly can be developed from a Curculio larva which is stung while so young; but we do not know how long the parasitic egg remains unhatched, and it must be remembered that it is a rule, wisely ordained and long known to exist in insect life, that the parasitic larva does not at first kill outright, but subsists, without retarding growth, upon the fatty portions of its victim, until its own growth is attained. Thus the first worm derives its nourishment from the juicy fruit, and grows on regardless of the parasite which is consuming its adipose substance, until the latter is sufficiently developed, and the appointed time arrives for it to destroy its prey by attacking those parts more vital.

This parasite, which I will now proceed to describe, belongs to the second sub-family (*Braconides*) of the Ichneumon-flies (*Ichneumonidæ*), and the venation of its wings, and 3-jointed abdomen, place it in the genus *Sigalphus*. Westwood (Synopsis, p. 63) gives three cubital panes or areolets in the front wings as characteristic of the genus; but Brullé (p. 510) and, as Mr. Cresson informs me, Westmael in his *Braconides de Belgique*, give only two, which is the number in our insect.

Sigalphus curculionis, Fitch—*Imago*—(Fig. 7, *a* male; *b* female). *Head* black, sub-polished and sparsely covered on the face with short whitish hairs; ocelli touching each other; labrum and jaws brown; palpi pale yellow; antennæ (Fig. 7, *c*) 27-jointed, filiform, reaching, when turned back, to middle joint of abdomen or beyond, the bulbus and small second joint rufous and glabrous, the rest black or dark brown, though 3–10 in many specimens are more or less tinged with rufous; 3–14 very gradually diminishing in size; 14–27 sub-equal. *Thorax* black, polished, the metathorax distinctly and broadly punctate, and the rest more or less distinctly punctate or rugose, with the sides sparsely pubescent. *Abdomen* pitchy-black, flattened, the dorsum convex, the venter concave, and the sides narrow-edged and slightly carinated; the three joints distinctly separated and of about equal length; the first joint having two dorsal longitudinal carinæ down the middle; all densely marked with very fine longitudinally impressed lines, and sparsely pubescent; (Dr. Fitch in his description published in the *Country Gentleman*, under date of September, 1859, states that these lines leave "a smooth stripe along the middle of its second segment and a large smooth space on the base of the third;" which is true of a few specimens, but not of the majority, in which the impressed lines generally cover the whole abdomen.) Ovipositor longer than abdomen, but when stretched in a line with it, projecting backwards about the same length beyond; rufous, with the sheaths black. *Legs* pale rufous, with the upper part of hind tibiæ and tarsi, and sometimes the hind femora, dusky. *Wings* subhyaline and iridescent, the veins pale rufous, and the stigma black. Length ♀, 0.15–0.16 inch, expanse 0.30; ♂ differs only in his somewhat smaller size and in lacking the ovipositor. In many specimens the mesothorax and the eyes are more or less distinctly rufous.

Described from 50 ♀♀, 10 ♂♂, bred June 23d–July 29th, 1870, from larvæ of *Conotrachelus nenuphar*, and 2 ♀♀ obtained from Dr. Fitch.

Larva (Fig. 8, *a*)—White, with translucent yellowish mottlings.

Pupa (Fig. 8, *c* ♀)—0.17 inch long; whitish, the members all distinct, the antennæ touching hind tarsi, the ovipositor curved round behind, reaching and touching with its tip the third abdominal joint, which afterwards forms the apical joint of imago; five ventral joints, which in the imago become much absorbed and hidden, being strongly developed.

Cocoon (Fig. 8, *b*)—Composed of one layer of closely woven yellowish silk.

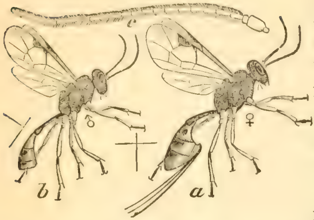
Variety rufus—Head, thorax and most of first abdominal joint entirely rufous, with the middle and hind tibiæ dusky, and the ovipositor three times as long as abdomen and projecting more than twice the length of the same beyond its tip.

Described from three ♀♀ bred promiscuously with the others. This variety is slightly larger and differs so remarkably from the normal form that, were it not for the absolute correspondence in all the sculpturing of the thorax and body, and in the venation of the wings, it might be considered distinct. The greater length of the ovipositor is very characteristic, and accompanies the other variation in all three of the specimens.

THE PORIZON CURCULIO PARASITE.

The other parasite works in very much the same manner, but instead of issuing the same summer as a fly, it remains in its somewhat tougher and more yellowish cocoon all through the fall and winter, and does not issue in the winged state till the following spring. This parasite was first discovered by Dr. Trimble, who sent me the cocoons from which I subsequently bred the perfect fly. It belongs to the first sub-family (*Ichneumonides*) of the Ichneumon-flies, and apparently to the genus *Porizon** of which it forms a new species. It is only necessary here to state that it differs from the other species in its reddish-brown abdomen, as well as in form, as may be readily seen by referring to the figures (Fig. 9, *a* female; *b* male; *c* antenna).

[Fig. 9.]



PORIZON CONOTRACHELI, N. SP.—*Head* pitchy-black, opaque, the ocelli triangularly placed and close together; eyes oval, polished, and black; face covered with a silvery-white pubescence; labrum rufous, with yellowish hairs; mandibles and palpi, pale yellowish-brown; antennæ inserted in depressions between the eyes, reaching to metathorax when turned back, filiform, 24-jointed; black with basal joints 6–1 becoming more and more rufous, the bulbus always distinctly rufous; bulbus rather longer and twice as thick as joint 3; joint 2 about one-third as long. *Thorax* pitchy-black, opaque, the sides slightly pubescent with whitish hairs, the mesothorax rounded and bulging anteriorly, the scutellum slightly excavated and sharply defined by a carina each side; metathorax with the elevated lines well defined and running parallel and close together from scutellum to about one-fourth their length, then suddenly diverging and each forking about the middle. *Abdomen* glabrous, polished, very slender at base, gradually broader and much compressed from the sides at the apex which is truncated; peduncle uniform in diameter and as long as joints 2 and 3 together; joints 2–5 subequal in length; color rufous with the peduncle wholly, dorsum of joint 2, a lateral shade on joint 3, and more or less of the two apical joints superiorly, especially at their anterior edges, black; venter more yellowish: ovipositor about as long as abdomen, porrect when in use, curved upwards when at rest, rufous, with the sheaths longer and black. *Legs,* including trochanters and coxæ uniformly pale yellowish-brown with the tips of tarsi dusky. *Wings* subhyaline and iridescent, with veins and stigma dark brown, the stigma quite large, and the two discoidal cells subequal and, as usual in this genus, joining end to end, but with the upper veins which separate them from the radial cell, slightly elbowed instead of being straight, thus giving the radial cell a quadrangular rather than a triangular appearance. ♂ differs from ♀ only in his somewhat smaller size and unarmed abdomen. Expanse ♀ 0.32 inch, length of body, exclusive of ovipositor 0.22; expanse ♂ 0.28, length 0.18.

Described from 3 ♀ ♀, 1 ♂ bred May 26th–28th, 1870, from cocoons received from Dr. I. P. Trimble, of New Jersey, and 1 ♀ subsequently received from the same gentleman—all obtained from larvæ of *Conotrachelus nenuphar*.

"But of what use are these parasites?" say you! Well, they can not, it is true, be turned to very practical account, because they are not sufficiently under our control; but it is a source of great satisfaction to those who have been looking for many years for some natural aid to help them in the artificial warfare waged against the Curculio,

* As I am informed by Mr. E. T. Cresson, of Philadelphia, who pays especial attention to the classification of the *Ichneumonidæ*, it might more properly be referred to Holmgren's genus *Thersilochus*, which differs from *Porizon* in the greater distance between the antennæ at base, and in the venation of the wing.

to know that besides its several cannibal foes, there are at last two true parasites which attack it. Indeed, with the knowledge of the Curculio enemies figured and described two years ago in the *American Entomologist*, and of the egg-destroying *Thrips* which I mentioned last year in a paper published in the Illinois State Horticultural Transactions for 1869 (p. 90), and these two parasites, the grower of our luscious stone-fruits may with good reason begin to hope for better days, for the prospect brightens. There is no philosophy in the statement of Mr. W. B. Ransom,* that we can never hope for assistance from parasites, because, as he confidently expresses it, "there are none at present but what have always existed!" Such argument will do for the believers in the old-school doctrine, that every thing was created just as we find it; but not for those who rightly comprehend the Darwinian hypothesis of development, and who believe that life is slowly undergoing change and modification to-day just as it ever has since it had an existence on this Earth. For my own part, nothing has ever appeared more absurd than the direct creation of something out of nothing, and I would as soon believe that we all dropped full grown from the clouds—instead of being brought into the world by natural means and gradually developing into manhood and womanhood—or that we have the same habits as our barbarous ancestors had; as to believe that the animal life about us is now as it was in the beginning! Therefore, though these Curculio parasites may have existed in this country long ere the white man first beheld its shores, yet they may only have acquired the habit of preying upon the Curculio within the last comparatively few years. Moreover, much benefit may be derived from their artificial propagation and dissemination, and—utopian as the scheme may appear—I intend next year, *Deo volente*, to breed enough of the first mentioned species to send at least a dozen to every county seat in the State, and have them liberated into some one's peach orchard.

THE APPLE CURCULIO.—*Anthonomus quadrigibbus*, Say.

"Prove all things; hold fast that which is good!"

This injunction of St. Paul applies with just as much force to us to-day, as it did in centuries past to the Thessalonians. In what has been said above about the Plum Curculio, we have had abundant opportunity of testing the soundness of the old proverb, and in ascertaining the history of the Apple Curculio, which I am about to give, it was very necessary to bear the advice in mind. It often takes years to undo the assertions of men who are in the habit of talking glibly of

* *Prairie Farmer*, June 4th, 1870.

that which they really know nothing about, and I ought to comment severely on what has been said about this insect; but I refrain from doing so, in this case, lest it be said that my words are prompted from personal considerations.* I shall therefore content myself with a plain narrative of this insect's habits.

First then, let us explain the differences between the perfect states of this insect and the Plum Curculio, that any one may distinguish between them.

The snout of the Plum Curculio hangs down like the trunk of an elephant; it is short, stout, and does not admit of being stretched out horizontally forwards; and as may be seen by referring to the figure (Fig. 1, *c*) is scarcely as long as the head and thorax together, and can be folded back between the legs, where there is a groove to receive it. The Plum Curculio is broadest across the shoulders and narrows behind, and moreover, the black sealing-wax-like, knife-edged elevations on the back, with the pale band behind them, characterize it at once from all our other fruit boring snout-beetles.

[Fig. 10.]

The Apple, or Four-humped Curculio (Fig. 10, *a*, natural size; *b*, side view; *c*, back view,) is a smaller insect with a snout which sticks out more or less horizontally and can not be folded under, and which in the male is about half as long, and in the female is fully as long as the whole body. This insect has narrow shoulders and broadens behind, where it is furnished with four very conspicuous humps, from which it takes its name. It has neither the polished black elevations nor the pale band of the Plum Curculio. In short, it differs generically, and never attacks stone fruit.

The size varies from 1-20th to nearly 1-12th of an inch, but the colors are quite uniform, the body being ferruginous or rusty-brown often with the thorax and anterior third of the wing-covers ash-gray —the thorax having three more or less distinct pale lines.

ITS NATURAL HISTORY.

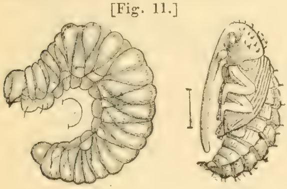
This beetle like the Plum-weevil is a native American insect, and has from time immemorial fed on, and bred in, our wild crabs. It is also commonly met with on the Thorn, and Mr. Wm. Saunders, of London, C.W., tells me that though abundant on the last named tree, it has not yet learned to attack the apple in his locality. It eventually learned to like our cultivated apples and pears, and is also found on quinces. At present it does considerable damage to the crop in some localities, though it yet prefers the wild to the cultivated fruit. Like

* My views on this subject, with comments on what has been said about this insect, may be found in a controversy, in articles published in the *American Entomologist and Botanist*, Vol. II, pp. 225–7 and 268–71; the *Prairie Farmer*, July 16th, 23d and Aug. 27th, 1870; and the *Journal of Agriculture*, Oct. 13th, and Nov. 10th and 17th, 1870.

the Plum-weevil also, it is single-brooded, and winters over in the beetle state, though I was led to believe differently a year ago. With its long thin snout it drills holes into the fruit, much resembling the puncture of a hot needle, the hole being round, with a more or less intense black annulation. and an ash-gray centre. Those holes made for food are about one-tenth of an inch deep and generally scooped out broadly at the bottom in the shape of a gourd. Those which the female makes for her eggs are scooped out still more broadly and the egg at the bottom is often found larger than the puncture at the orifice —thus indicating that it swells from absorption, by a sort of endosmosis, of nutritive fluid from the surrounding fruit, just as the eggs of many saw-flies and of some other snout-beetles are known to do.

The egg is fully 0.04 of an inch long, nearly oval, not quite three times as long as wide, and of a yellowish color, with one end dark and empty when the embryo larva is well formed. The egg-shell is so very fine that the larva seems to gradually develop from it instead of crawling out of it; and by taking a matured egg and gently rolling it between the thumb and finger, the young larva presents itself, and at this early age its two little light brown mandibles show distinctly on the head. As soon as this larva hatches it generally goes right to the heart of the fruit and it feeds there around the core, producing much rust-red excrement, and acquiring a tint of the same color. It feeds for nearly a month, and when full grown presents the appearance of Figure 11, *b*.

[Fig. 11.]



b *a*

It differs so remarkably from that of the Plum Curculio that the two insects can be distinguished at a glance even in this masked form. It is softer, the chitinous covering being thinner and much whiter. It cannot stretch straight and travel fast as can that of the Plum Curculio, but curls round with an arched back, joints 4–7 being larger than the preceding. It is more crinkled, each joint being divided into three principal folds much as in the common White Grub. The space between the folds is frequently bluish-black, and there is a very distinct, continuous, vascular, dorsal line of a bluish color. It has no bristles like *nenuphar* except a few weak ones on the first joint, arising from some ventral tubercles which remind one of feet. The head is yellowish-brown with the jaws somewhat darker, and the breathing pores, except that in the fold of the first joint, are not easily seen.

IT TRANSFORMS IN THE FRUIT.

The fruit of the wild crab containing this larva never falls, and the fruit of our cultivated apples seldom; and in this respect the effect of its work differs remarkably from that of the Plum Curculio, or even of the Codling Moth. Why such is the case it would be difficult to explain! It is one of those incomprehensible facts which at every turn confront the student of Nature's works. We might with equal reason ask why it is that of the two stone fruits, the plum and the cherry, the larger falls and perishes and the smaller hangs on and lives, when infested with the Plum Curculio; and of the two pomaceous fruits, the apple and the haw, the larger likewise falls and perishes and the smaller hangs on and lives, when infested with similar larvæ? Most persons would naturally infer that the larger instead of the smaller fruits would best resist the injurious gnawings of the worm within; and though we may explain away the paradox by supposing that the longer stem of the smaller fruits prevents the injury from reaching its juncture with the branch, so readily as it does through the shorter stem of the larger fruits; or that the greater weight of the larger fruit causes it to fall so readily; yet this is only assuming, and I doubt whether the vegetable pathologist will ever be able to show the peculiarities of the fruits which cause the different effects.

The larva of the Apple Curculio has no legs and is so humpbacked that it cannot stretch out, and would cut a very sorry figure in attempting to descend the tree. Therefore, as the fruit containing it mostly hangs on the tree, the insect is effectually imprisoned. But Nature's ways are always ways of wisdom and her resources are inexhaustible! Consequently we find that instead of having to go under ground to transform, as does the Plum Curculio, the normal habit of our Apple Curculio is to transform within the fruit. The larva, after becoming full fed, settles down in a neat cavity, and soon throws off its skin and assumes the pupa state, when it appears as at Figure 11, *a*. After remaining in this state from two to three weeks it undergoes another moult and the perfect beetle state is assumed. We thus see that the Apple Curculio is cradled in the fruit in which it was born till it is a perfect beetle, fully fledged, and ready to carry out the different functions and objects of its life. In other words, it never leaves the fruit, after hatching, till it has become a perfect beetle. This fact I have fully tested by breeding a number myself both from infested crabs which I collected, and from cultivated apples, also infested, that were kindly forwarded to me by Mr. J. B. Miller, of Anna, Illinois. I learn also from Mr. George Parmelee of Old Mission, Michigan, that he has satisfied himself of the same trait in the natural history of this insect, and I fully convinced myself that such was the normal habit, by repeatedly removing the full grown larva from the fruit and placing it on the surface of the ground, when, in every instance, it would make no attempt to bury itself, but would always transform on the surface.

THE AMOUNT OF DAMAGE IT DOES.

The observations that I have been able to make on this insect's work in our cultivated orchards are limited, but I think that it attacks with equal relish both summer and winter apples. Whenever a beetle has perfected in the fruit, it cuts quite a large hole for its escape, and these holes are sufficiently characteristic to enable one who has paid attention to the matter to tell with tolerable certainty whether an apple has been infested with Apple-worm, Plum Curculio, or Apple Curculio—even after the depredator has left.

In the southern portion of Illinois and in some parts of Missouri this insect is very abundant and does much damage to the apple crop; it occurs in greater or less numbers in most States of the Union, but in other localities again its work is scarcely ever seen, and I am satisfied that the damage it does has been much overrated. We can only judge of the future by the past, and though we may expect this insect to increase somewhat with the increase of our orchards, it is folly to suppose that it can go on increasing in geometrical ratio; and the pretty mathematical calculations which are intended to alarm the cultivator at the gloomy prospects of the future, are never made by those who understand the complicated net-work in which every animal organism is entangled, or who rightly understand the numerous influences at work to keep each species within due bounds. Such figures look well on paper, but, like air-castles, there is nothing real about them.

Our apples suffer much more, in many localities, from the gougings of the perfect beetle and the burrowings of the larva of the Plum Curculio, than they do from the work of this Apple Curculio; and this was so much the case in my own locality the past summer, that I found a dozen larvæ of the former in apples, where I found one of the latter.

At the late meeting of the Illinois State Horticultural Society, Mr. E. Daggy, of Tuscola, Illinois, had on exhibition some pears that were very much deformed and gnarled. This injury had been caused by the Apple Curculio, which Mr. Daggy recognized from figures and specimens which I had with me. Upon examining the pears I found a little dark circular spot which indicated distinctly where the snout of the beetle had been inserted. This spot was the center of a hard and irregular but generally rounded knot or swelling, which was sunk in a depression of the softer parts of the pear, thus indicating that the growth, by some property of the puncture, was checked and hardened, while the other parts went on growing and swelling. Some of the fruit was so badly disfigured that it could no longer be recognized, and Mr. Daggy informed me that his Vicar of Winkfield, Bergamott and "Sugar" pears were most affected in this way, and that his Duchesse pears were unblemished.

While the fruit is growing these punctures, in almost every in stance, cause just such calloused spots and deformities as those des cribed above, but when the fruit is ripe they have a far more pernicious effect, for they generally cause the fruit to rot. It is now a well established fact that the common Plum Curculio causes the dreaded rot in peaches, plums, etc., to spread at a fearful rate by the punctures and gougings which it makes on the ripening fruit; and that where this predisposing influence is guarded against, such rot is generally confined to comparative narrow limits or does not occur at all. Many varieties of apples are disposed to rot in a similar manner, and to fall from the tree just as they are ripening. This rot in apples, as may be seen from the transactions of our State Horticultural Society, was very prevalent last fall—the Rawles Janet being especially predisposed to it—and there can be no doubt but that the punctures and gnawings of the little Turk, combined with those of the Apple Curculio are likewise the pricipal agents in producing it; for I have over and over again noticed the rot to spread in a circle from these punctures, not only on hanging fruit but just as invariably upon fruit punctured after it was plucked. Whether we believe that the fungus growths, often noticeable on such rotting fruit, are the direct result of the punctures, or that the latter only act indirectly by furnishing a proper nidus for the infectious fungus-spores which are supposed to be ever floating in the atmosphere, is a question which I shall not now stop to consider, though I have my own views which are somewhat heterodox. In either case, the Curculios are just as much to blame, and this should be an additional incentive to a general warfare upon them. Judge A. M. Brown, of Villa Ridge, has noticed that some varieties of apples are much more subject to rot and also more subject to the attacks of Curculios than others,* and it is to be hoped that he will make further observations and give us a reliable list of such varieties, and that other fruit-growers will do the same.

THE SEASON OF THE YEAR DURING WHICH IT WORKS.

The beetles come from their winter quarters and begin to work on the fruit at about the same time as does the Plum Curculio—if anything, a little later. They have generally got fully to work, and larvæ may be found already hatched by the first of June, and they may be found in the fruit, in one stage or another, all along through the months of June and July and the greater part of August.

REMEDIES AND PREVENTIVE MEASURES.

Notwithstanding we have had reports, published in the columns of our agricultural papers, of the relative number of Apple and Plum Curculios captured from peach trees by jarring with the Curculio-catcher, I am fully convinced that such reports were not based on facts, and that we may never expect to subdue this insect by the jarring process. It is not as timid or as much inclined to drop as the Plum Cur-

Prairie Farmer, January 28, 1871.

culio, and though it can occasionally be brought down, it generally remains defiantly on the fruit or on the bough, through the gentlest as well as the severest jarring of the tree. Indeed, its habit of transforming in the fruit, places it in a great measure beyond our control, and I fear that this is one of the few insects with which we can do but little by artificial means. But we have only just commenced to understand this foe, and there is much yet to learn about it. I sincerely hope that the few facts which have been here given, will increase the reader's interest in this insect and enable him to carry on future observations and experiments with a better understanding; so that they will at last result in making us masters of this rather difficult situation. Mr. H. Lewelling, of High Hill, Montgomery county, Missouri, who has had much of his fruit injured by this insect, informs me that Tallman's Sweet is preferred by it to all other varieties, and our observations should, as much as possible, tend in the direction of deciding which varieties are most subject to, and which most exempt from its attacks; and which varieties fall most readily when infested by it. For it is obvious that with our present knowledge, the only real remedy which yet exists, is the destruction of the infested fruit, whether upon or off the tree; and it may turn out that although we cannot jar down the beetles, we can jar down much of the infested fruit, which would, without jarring, remain on the trees.

ANTHONOMUS QUADRIGIBBUS, Say—*Larva* (Fig. 11, *b*)—Average dorsal length when full grown 0.45 inch; soft and white, with a very few sparse soft hairs; arched and wrinkled Lamellicorn-fashion, the space between the wrinkles, and a distinct dorsal vascular line, bluish-black. Head free and almost perpendicular, yellowish-brown with the mandibles darker. A pair of polished ventral tubercles on each of the three thoracic joints, and each bearing a distinct bristle.

Pupa (Fig. 11, *a*)—Average length 0.40 inch. Whitish, the snout of ♀ reaching beyond tip of wing-cases, that of ♂ not much beyond the elbow of middle femora and tibiæ. Thorax with a few short stiff hairs springing from slight conical elevations. Wing-cases showing the striæ and humps of future beetle, the tip of the upper case usually terminating in a thorn. The nine abdominal joints deeply and distinctly separated, the first showing a rounded scuttellar tubercle; the sides angular, conically ridged and armed on each joint with two brown thorns or bristles, which become stouter towards apex; a transverse dorsal row of about eight similar bristles on the posterior sub-margin of each joint, also becoming larger towards apex: Terminal subsegment ending in *one* stout, slightly curved, thorn.

THE QUINCE CURCULIO—*Conotrachelus cratægi*, Walsh.

HOW IT DIFFERS FROM THE OTHERS.

This insect has been called the Quince Curculio by Dr. Trimble, and though it breeds in other fruits, the name is a good one as it will enable us to distinguish it at once from our other fruit snout-beetles. I have had the beetle in my cabinet for several years, but knew nothing of its larval history till a year ago last fall. It breeds very abundantly in our common haws, and I raised a number of them the present season from the fruit of the Pear or Black Thorn (*Cratægus tomentosa*) obtained from Mr. Walsh.

[Fig. 12.]

Though belonging to the same genus as our Plum Curculio, and having very much the same form, as may be seen by referring to the figure, (Fig. 12, *a* side view; *b* back view), yet it differs remarkably in its habits from both of the preceding weevils. It is, like them, an indigenous species, and its original fruit was evidently the wild Haw, which in the West it yet seems to prefer to the cultivated fruits. But in the East it has become very injurious to the Quince and, as we might naturally expect, also attacks the Pear, and especially the Lawrence and other late varieties. In September, 1868, I received specimens from W. W. Sweet, of Highstown, N. J., with the statement that they were found on pears, and Dr. Trimble at a late meeting of the New York Farmers' Club (Oct. 22, 1870), gave the following account of its injuries in New Jersey the present year:

"Yesterday five or six hundred were taken from the bottoms of two barrels of quinces, although those quinces had only been gathered four days before. A friend of mine has a quince orchard of 286 trees. These trees this season should average seventy or eighty quinces to a tree, making more than twenty thousand. Upon a most careful search I was unable to find one specimen perfect, or clear of one or more blemishes caused by the punctures of this insect. Frequently four, five, or six grubs will be found in a single quince. Mr. Goldsmith, the owner, keeps this orchard in first-rate order; he has faithfully kept out the borers, so fatal to the quince trees; has fertilized very freely, and the cultivation is perfect. He told me yesterday, that his crop this year is thirty barrels, which will yield him about $125. Had this insect let him alone he should have had at least 100 barrels, worth $800 to $1,000. Many of his later pears, including the Seckel and Lawrence, have suffered greatly, though not to the same extent as his quinces. A few days ago he emptied a barrel of cullings, chiefly Lawrence pears, and in and near the bottom of that barrel were found at least 400 of these grubs. A month ago I visited the orchards attached to one of the best nurseries in Pennsylvania, and I found the sad evidence of the presence of this enemy. Even the Seckel pears, though very abundant, were almost worthless; later varieties still worse. Mr. Fuller tells me that he has seen this season, in Western New York, the same condition of fruit at a well known nursery, even the Duchesse pears almost totally destroyed. This fruit enemy seems yet confined to localities; but is spreading rapidly."

This beetle was first very briefly described by Mr. Walsh in a note in the *Prarie Farmer* for July 18th, 1863, p. 37, from specimens found by him on the hawthorn, but until I bred it this spring, nothing was known of its larval history. It is a somewhat larger insect than the Plum Curculio, has a comparatively longer snout, and is very broad-shouldered; thus tapering just the opposite way to the Apple Curculio. Its general color is a tolerably uniform ash-gray, mottled more or less with ochre-yellow, dusky and whitish, and it has a dusky somewhat triangular spot at the base of the thorax above, and seven distinct narrow longitudinal elevations on the wing-covers, with two rows of punctures between each.

This beetle differs further from the others, in the fact that it does not appear, even in the latitude of St. Louis, till about the first of June, and I have had its larvæ of the previous year in the ground in May, when the newly hatched larvæ of the Plum Curculio were already working destruction in the fruit. In some of the more northern States it would not appear till the middle of July.

ITS TRANSFORMATIONS AND HABITS.

This snout-beetle does not make a crescent like the Plum Curculio; but, like the Apple Curculio, makes a direct puncture for the reception of its egg, the hole being somewhat larger than that of the latter, and the bottom of the cavity similarly enlarged and gnawed, so as to form a neat bed for the egg. The egg is very similar to that of the Plum Curculio, and hatches in a few days after being deposited. In all probability it also swells and enlarges somewhat before hatching. The larva works for the most part near the surface of the fruit, and does not enter to the heart. It is of the general form of that of the Plum Curculio, and differs principally in being somewhat larger, more opaque-white, and in having a narrow dusky dorsal line and a distinct lateral tubercle on each joint. When full grown, which is in a month or more from the time of hatching, it leaves the fruit through a smooth cylindrical hole and burrows two or three inches into the ground. Here, singularly enough, it remains all through the fall, winter and spring months without changing—no matter whether it left the fruit as early as the first of August or as late as the first of October. This is the peculiar feature of the insect, namely, that it invariably passes the winter in the larva state, and does not even assume the pupa state till the fore part of May, or a few days before issuing as a beetle. In this respect it resembles the nut-weevils which infest our hickory-nuts, hazel-nuts and acorns. In higher latitudes than that of St. Louis, there is evidence that some of the late hatched larvæ do not leave the haws they infest till frost overtakes them, but pass the winter within the fruit as it lies on the frozen ground. The pupa differs only from that of the Plum Curculio in the greater length of the proboscis.

I have already referred to the fact that Dr. Fitch supposed the Plum Curculio to be two-brooded, and those who have read his "Address" on this insect will readily perceive that he based his opinion on finding what he took to be its larvæ in the tender bark of a pear twig late in the fall, and on finding what he similarly mistook for such larvæ in haws in winter. Of course, we know positively now that the Plum Curculio does not so breed in pear twigs, and it is very evident that what Dr. Fitch took to be Plum Curculio larvæ in such a twig, were the young of some other insect, or perhaps even the eggs of some leaf-hopper (*Tettigonia*), which are generally placed in the position described by him. But, though this first error of Dr. Fitch's has been explained away, the second never has till now, when we may assume, with great reason, that the larvæ which misled the Doctor, and which were found in haws in winter time, were in reality the larvæ of our Quince Curculio. How easily are fallacies exploded, and errors corrected, even years after they are committed, by a few well tested facts!

The two former Curculios which we have been considering have a beetle existence of between nine and ten months, during most of which time, or as long as the weather is sufficiently mild, they feed in the manner described. The present species has a beetle existence of not more than two months, and as though aware of the short term allotted to it for enjoyment, it endeavors to make the best use of its time. Consequently we find it more ravenous than either of the other species, and it is really astonishing how much this insect eats. It excavates immense holes for food, often burying itself in them completely, and I have known apples furnished to these beetles in confinement, to have their substances so completely devoured that nothing but the rind was left. Two years ago last fall there was scarcely a quince that came into the St. Louis market that was not marred by numbers of large gougings, and though I was then inclined to attribute such holes to the gnawings of grasshoppers, I feel pretty well convinced at present that the work might with more justice have been attributed to this Quince Curculio.

The question will naturally arise, since this insect breeds in the Haw, the Quince and the Pear, whether it will also breed in the closely allied Apple? So far as my experiments go, they indicate clearly that it will not; for although the beetle will eat and greatly disfigure apples, when no other nourishment is at hand, yet a number which I confined to a large branch of an apple tree on the 14th of June last, absolutely refused to deposit eggs, and died three weeks afterwards.

REMEDIES.

Very fortunately this insect drops as readily when alarmed as does the Plum Curculio, and the jarring process will be found just as effectual in catching it, with the additional advantage that the jarring need only be carried on for about ten weeks of the year, namely, from about the first of June to the middle of August in this latitude. Moreover, in accordance with its late appearance, we find that, according to Dr. Trimble, whenever it attacks pears, it prefers the late ripening varieties. Again, it is, like the Plum Curculio, nocturnal in its habits, and secretive during the day, so that the Ransom process will undoubtedly prove effectual with it, if used at the right season. All fruit that falls should be destroyed, and as we know that the larva hibernates in the ground, many of them will be injured and destroyed by late stirring of the soil.

CONOTRACHELUS CRATÆGI, Walsh—*Larva*—Average length when full grown 0.32 inch; 4½ times as long as wide, and straight. Opaque whitish, with a narrow dusky dorsal line, generally obsolete on thorax, and a few very short hairs. Distinct lateral tubercles on all the joints. Head rufous with mandibles black, except at base, and distinctly two-toothed at tip.

Pupa—Average length 0.28 inch. Snout reaching a little beyond elbow of middle tibiæ and tarsi, with two stout rufous thorns near the origin of antennæ, two more at base and sometimes others more toward the tip. Head and thorax also armed with such thorns, and also two to each elbow of the femora and tibiæ. Wing cases with rows of short rufous bristles along the elevations between the striæ. Abdomen cylindrical, the basal joint with a central scutellar bristleless tubercle and two others, one each side of it, each bearing a bristle; the other joints conically tubercled, laterally, each tubercle bearing a stout bristle, and each joint bearing dorsally about four other bristles on its posterior sub-margin. Terminal sub-segment squarely cut off and bearing *two* stout inwardly-curved brown thorns.

THE PLUM GOUGER.—*Anthonomus prunicida*, Walsh.

ITS CHARACTER, DISTRIBUTION, AND FOOD.

This name was given by Mr. Walsh to another indigenous weevil which is represented enlarged in the accompanying illustration (Fig. 13). It is easily distinguished from either of the preceding weevils, by its ochre-yellow thorax and legs, and its darker wing-covers, which are dun-colored, or brown with a leaden-gray tint, and have no humps at all. Its snout is not much longer than the thorax, but as in the Apple Curculio, projects forwards, or downwards but cannot be bent under as in the Plum Curculio. This insect was first described in the *Prairie Farmer* for June 13th, 1863, and the description was afterwards republished in the Proceedings of the Boston Society of Natural History for February, 1864.

[Fig. 13.]

Mr. Walsh gave such a good account of it in his report as Acting State Entomologist of Illinois, that it is unnecessary for me to go into detail, and I will therefore only briefly allude to those traits in its history which are well established.

The Plum Gouger seems to be unknown in the Eastern States, or at least is not common there; but it is very generally distributed throughout the Valley of the Mississippi. As a rule it is much less common and does much less injury than the little Turk, though in some few districts it is found equally abundant, and I received specimens on the first of June last, from my esteemed correspondent Mr.

Huron Burt, of Williamsburg, Callaway county, Mo., with the statement that it was doing great damage to the plums in that locality, though the little Turk was scarcely met with. There is a plum known there as "Missouri Nonsuch" which, though said to be Curculio proof, is worked upon very badly by the Gouger.

The Plum Gouger is often found on wild crab trees, and may, like the Plum Curculio, occasionally deposit and breed in pip fruit; but it is partial to smooth-skinned stone-fruit such as prunes, plums, and nectarines, and it does not even seem to relish the rough skinned peach.

OFTEN MISTAKEN FOR THE PLUM CURCULIO.

It has often been confounded with the Plum Curculio, and was once supposed by my friend L. C. Francis, of Springfield, Ills., to be the male of that species. We all have a right to suppose what we please, and as long as our suppositions are not thrust on the public for ascertained facts, they can do no possible harm. But Mr. J. P. Williamson, of Des Moines county, Iowa, is not satisfied with supposing this or some other straight-snouted weevil, to be the female of the Plum Curculio, but, in a last summer's issue of the *Prairie Farmer*, not only emphatically speaks of it as such, but, finding that these supposed females frequent the trees two weeks earlier than the males, (?) he concludes for some unexplained reason, that the sole object of visiting the fruit is for the deposition of eggs; and straightway hatches the theory that the Plum Curculio can do no harm till the males appear! Consequently, instead of jarring our trees as long as fruit remains on them, we are informed by Mr. Williamson that it is only necessary to jar them about six weeks.

And thus it always is with men who do not sufficiently understand the absolute importance of care and caution in reading Nature's secrets: from supposition to assumption; from assumption to theory; from theory to advice, which—it is unnecessary here to say—is of a most pernicious character.

ITS TIME OF APPEARANCE.

This beetle appears in the spring about the same time as the Plum Curculio, but as no eggs are deposited after the stone of the fruit becomes hard, and as its larva requires a longer period to mature than that of the latter, its time of depositing is shorter, and the old beetles generally die off and disappear before the new ones eat their way out of the fruit, which they do during August, September, and October, according to the latitude.

ITS NATURAL HISTORY.

Though we have no absolute proof of the fact, analogy would lead us to believe, and in my own mind there is no doubt, that this insect passes the winter in the beetle state, and that it is, like the other species, single-brooded. Both sexes bore cylindrical holes in the fruit for food, and these holes are of the exact diameter of the snout, and consequently somewhat larger than those of the Apple Curculio. These holes are broadened at the bottom, or gouged out in the shape of a gourd; and especially is this the case with those intended by the female for the reception of an egg. The egg, in this case also, enlarges from endosmosis, and it is probable that all weevils that make a puncture for the reception of their eggs, gnaw and enlarge the bottom, not only to give the egg room to swell, but to deaden the surrounding fruit, and prevent its crushing such egg—the same object being attained by the deadened flap made by the crescent of the little Turk. Wherever this insect abounds, plums will be found covered with its holes, the great majority of them, however, made for feeding purposes. The gum exudes from each puncture, and the fruit either drops or becomes knotty and worthless.

The young larva which hatches from the egg, instead of rioting in the flesh of the plum, or remaining around the outside of the kernel, makes an almost straight course for that kernel, through the yet soft shell of which it penetrates. Here it remains until it has become full-fed, when by a wise instinct it cuts a round hole through the now hard stone, and retires inside again to change to the pupa and finally to the beetle state. When once the several parts of the beetle are sufficiently hard and strong, it ventures through the hole which it had already providently prepared for exit with its stronger larval jaws, and then easily bores its way through the flesh and escapes.

It must not be forgotten that, while the kernel of the fruit is yet soft, the larva of the little Turk often penetrates and devours it; but in this case the soft stone is more or less reduced to reddish powder, whereas the larva of the Plum Gouger enters the stone and feeds on the inside while the outside hardens. The normal habit of the former is to feed on the outside; that of the latter on the inside of the stone.

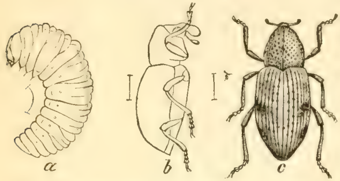
REMEDIES.

This Plum Gouger is about as hard to deal with as the Apple Curculio. It drops almost as reluctantly and we therefore cannot do much by the jarring process to diminish its numbers. Moreover it takes wing much more readily than the other weevils we have mentioned; and though fruit that is badly punctured for food, often falls prematurely to the ground, yet, according to Mr. Walsh, that infested with the larva generally hangs on the tree until the stone is hard and premature ripening sets in. In all probability the stunted and prematurely ripened fruit containing this insect will jar down much more readily than the healthy fruit, but I have so far had no opportunity of making any practical observations myself, and must conclude by hoping that our plum-growing members will make the proper experiments and give us the results.

THE STRAWBERRY CROWN-BORER.—*Analcis fragariæ* N. sp.

This is another indigenous insect, which seems to be confined to our Mississippi Valley, for I have heard no complaints in any of the Atlantic States, of injuries that could be attributed to this weevil. In the *Maine Farmer* for July 25th, 1867, we find a brief reference, made by Mr. G. E. Brackett of Belfast, Me., in answer to a certain "E. B.," of a "worm that eats into the crown of the plant and kills it." The worm referred to was, in all probability, the Crown-borer under consideration, but as no postoffice address of the questioner is given, the paragraph might just as well never have been written, for any light that it throws on the distribution of the insect. However, no such insect has ever been mentioned by our Eastern writers on the Strawberry, and we must necessarily conclude that it does not exist in the Atlantic States.

[Fig. 14.]



This insect has done considerable damage to the strawberry crop in the southern portion of Illinois, especially along the line of the Illinois Central Railroad; and I have seen evidence of its work in St. Louis county, Mo. At the meeting of the Southern Illinois Fruit Growers' Association, held at South Pass, in November, 1867, several complaints were made by parties from Anna and Makanda, of a white worm which worked in the roots of their strawberries and in 1868, the greater portion of the plants of a ten-acre field at Anna, belonging to Mr. Parker Earle, was destroyed by it.

In the fall of 1869 I had some correspondence with Mr. Walsh on this insect, and learned that he had succeeded in breeding it to the perfect state; and had it not been for his untimely death, its history would no doubt have been published a year ago. Through the kindness of Jos. M. Wilson, of Sterling, Whiteside county, and of J. B. Miller, of Anna, Union county, Ills., I received during the past year specimens of the larvæ, from which I succeeded in rearing the perfect beetle. It is therefore by the aid of these gentlemen, and especially from the experience of Mr. Miller, that I am enabled to give the above illustrations (Fig. 14) of the Strawberry Crown-borer, and the following necessarily imperfect account of its mode of working. I give them in the hope that they will prompt further investigation, and serve as a clue to enable others who have opportunity, to increase our knowledge of this pest; for there is much yet to learn of its habits, and consequently of the best means of fighting it.

From the middle of June to the middle of July in Southern Illinois, and later further north, the larva hatches from an egg which, in all probability, is deposited in the crown of the plant, and it immediately commences to bore its way downwards, into the pith. Here it remains till it has acquired its full size, working in the thick bulbous root and often eating through the more woody portions; so that when frost sets in, the plant easily breaks off and is heaved out of the ground. When full grown it presents the appearance of Figure 14, *a*, being a white grub with arched back and tawny-yellow head, and measuring about one-fifth of an inch when stretched out. It undergoes its transformations to the pupa and perfect beetle states within the root, and the latter makes its appearance above ground during the month of August.

The beetle (Fig. 14, *b* side view; *c* back view) is about 1-6th of an inch in length, of a chestnut-brown color, and marked and punctured as in the figure.

From analogy we may infer that the beetle feeds on the leaves of the strawberry, for it is a very general rule with snout-beetles, that the perfect insects feed on the leaves of such plants as they infest in the larva state. But whether it lives on through the winter as a beetle and does not commence depositing eggs again till the following June; or whether it is double-brooded and produces a second lot of larvæ which pass the winter in the roots, are questions which are not yet decided; and until we get a more comprehensive knowledge of this insect's ways and doings, we shall be in a measure powerless before it. From all the facts that can be obtained, the first hypothesis is the correct one, and in that event we can, in an emergency, easily get rid of this pest by plowing up and destroying the plants soon after they have done bearing, or say about the latter part of June in the latitude of St. Louis. By doing this the whole brood of borers will perish with the plants. Most strawberry-growers renew their plants, in some way or another, about every three years, and where this insect abounds, it will be best subdued by destroying the whole bed at the time already suggested and afterwards planting a new one; rather than by annually thinning out the old and leaving the new plants in the same bed. Here we have an effectual means of extirpating the little pest, if, as I believe, the first hypothesis is the correct one; but if the second hypothesis be correct—i. e., if the insect be double-brooded—then it will avail nothing to carry out the above suggestions, and we thus see how important it is to thoroughly understand an insect's habits in order to properly cope with it. Though we may occasionally hit upon some plan of remedying or of preventing an insect's injuries without knowing its habits, yet as a general rule we but grope in the dark until we have learned its natural history!

According to Mr. Miller, all plants infested with this larva are sure to perish, and he has also noticed that old beds are more apt to be injured by it than new ones.

In one of the roots received from him, I found a parasitic cocoon, so that there is every reason to believe that, as is so very generally the case with insects, this noxious species has at least one natural enemy which will aid us in keeping it in due bounds. Indeed, Mr. Miller so often found this parasitic cocoon, that he at first surmised that the Crown-borer spun it. But no snout-beetle larvæ spin cocoons.

This Crown-borer must not be confounded with another white worm of about the same size which lives in the ground and subsists on the roots by devouring them from the outside. This last may always be distinguished by having six distinct legs near the head, and its habits are quite different. It occurs earlier in the season, and, as I have proved the past summer, is the larva of the little clay-yellow beetle, known as the Grape-vine Colaspis (*Colaspis flavida*, Say). A full account of this last insect, with illustrations, will be given in a later portion of this Report.

The Crown-borer belongs to the genus *Analcis* which is distinguished by its sub-cylindrical oblong-oval body, its short robust snout which fits into a deep grove, its 10-jointed antennæ, and its simple or unarmed thighs. As it is a new species I subjoin a description of it for the scientific reader :—

ANALCIS FRAGARIÆ, N. Sp.—*Imago*, (Fig 14, *b*, *c*)—Color deep chestnut-brown, sub-polished, the elytra somewhat lighter. Head and rostrum dark, finely and densely punctate and with short coarse fulvous hairs, longest at tip of rostrum ; antennæ rather lighter towards base, 10-jointed, the scape much thickened at apex, join 2 longest and robust, 3 moderately long, 4–7 short, 8–10 connate and forming a stout club. Thorax dark, cylindrical, slightly swollen across the middle and uniformly covered with large thimble-like punctures, and with a few short coarse fulvous hairs, unusually arranged in three more or less distinct longitudinal lines ; pectoral groove ending between front legs. Abdomen with small remote punctures and hairs which are denser towards apex. Legs of equal stoutness, and with shallow dilated punctures and uniform very short hairs Elytra more yellowish-brown, dilated at the lower sides anteriorly, and with about 9 deeply-punctured striæ, the striæ themselves sometimes obsolete ; more or less covered with coarse and short pale yellow hairs which form by their greater density, three more or less conspicuous transverse bands, the first of which is at base ; between the second and third band, in the middle of the elytron, is a smooth dark-brown or black spot, with a less distinct spot of the same color below the third, and a still less distinct one above the second band. Length 0.16 inch.

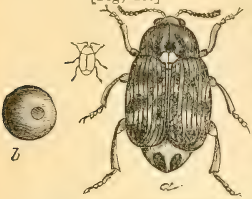
Described from four specimens bred from strawberry-boring larvæ. The black spots on the elytra are quite distinct and conspicuous on two specimens, less so on one, and entirely obsolete on the other.

Larva, (Fig. 14 *a*)—White with back arched Lamellicorn-fashion. Head gamboge-yellow, glabrous, with some faint transverse striations above mouth ; mandibles rufous tipped with black ; labrum emarginate, and with palpi, pale. A faint narrow dorsal vascular line. Legs replaced by fleshy tubercles. Length 0.20 inch when stretched out.

THE PEA-WEEVIL—*Bruchus pisi*, Linn.

Our common garden pea has not many insect enemies, for with the exception of the Striped Flea-beetle (*Haltica striolata*), which gnaws numerous small holes in the leaves, and the Corn-worm *alias* Boll-worm (*Heliothis armigera*), which eats into the pod, there are very few others besides the Pea-weevil under consideration. This species alone is so numerous, however, as to be a serious drawback to pea culture in this part of the country.

[Fig. 15.]



The term *Bruchus*, meaning a devourer, was given by the celebrated Linnæus to a genus of beetles which at first appear to have very little resemblance to the Snout-beetles. They form, however, at present, a sub-family (*Bruchides*) of the great Snout-beetle family, though they posses nearly as close affinities to the great *Chrysomela* family, and really form a connecting-link between the two. They are characterized by a depressed head and very short snout, by the antennæ being 11-jointed, straight and but slightly thickened towards the end, by the wing-covers being shorter than the abdomen, and by the rather long hind legs and much swollen thighs. Their larvæ are short, arched, and swollen in the middle, with a comparatively small head; and their depredations are confined all over the world, to leguminous or pod-bearing plants—another beautiful illustration of the "Unity of Habits" referred to on page 9.

They are far more abundant in the tropics than in more temperate climes, and in North America we have not many species to contend with. With the exception of the Honey-locust seed-weevil (*Spermophagus robiniæ*, Fabr.), which I have bred from the seeds of that tree, there are only two species, namely: the Pea and the Bean weevils that are really injurious in our State, though *Bruchus discoideus*, Say, often badly infests the seeds of *Ipomea*. A third species, however, namely, the Grain Bruchus of Europe, has lately been introduced into this country, and may some day become unduly multiplied in our midst.

The Pea-weevil is very generally dubbed "Pea-bug," but this latter term is not nearly so appropriate as the former, to which it should give way. Though everybody may notknow by sight the perfect beetle, yet every one has most assuredly seen the work of the worm, and though knowledge of the fact may not add to our enjoyment of a mess of green peas, yet the fact nevertheless remains, that those of us in the Mississippi Valley who indulge in this delicious esculent, necessarily devour a young worm with nearly every pea that we eat. Gray's oft quoted lines,

—"Where ignorance is bliss,
'Tis folly to be wise,"

Would seem to apply here with great force; but when we reflect that the diminutive and almost imperceptible worm, nourished so to speak in the very marrow of the pea, really has no flavor and produces no injurious effects on the human system; we can chuckle in our sleeves and console ourselves with the thought that, notwithstanding the above truism, "wisdom is justified of her children." Neither this nor any other of the true weevils mentioned in this paper, can do harm when taken as food in the larva state, but there is good testimony that the hard-shell beetles are injurious when fed in a ground or unground condition, along with the seeds they infest, either to man or to other animals.

The Pea-weevil which is here well illustrated, Figure 15, *a* showing a back view, and 17, *b* a side view, the small outlines at the sides showing the natural size, is easily distinguished from all other species of the genus with which we are troubled, by its larger size, and by having on the tip of the abdomen projecting from the wing-covers, two dark oval spots which cause the remaining white portion to look something like the letter T. It is about 0.18—0.20 inch long, and its general color is rusty-black, with more or less white on the wing-covers, and a distinct white spot on the hinder part of the thorax near the scutel. There is a notch on each lateral edge of the thorax, and a spine on the under side of the hind thighs near the apex. The four basal joints of the antennæ and the front and middle shanks and feet are more or less tawny. It is supposed to be an indigenous N. A. insect, and was first noticed many years ago around Philadelphia, from whence it has spread over most of the States where the pea is cultivated. This supposition is probably the correct one though we have no means at present of proving it to be so, and certain it is that, as the cultivated pea was introduced into this country, our Pea-weevil must have originally fed on some other indigenous plant of the Pulse family. It is at present found in the more southern parts of Europe and in England, and is one of the few injurious insects which have found their way there from this country; but in accordance with the facts given in my last Report, under the head of "Imported Insects and Native American Insects," which clearly prove that our native plants and insects do not become naturalized in the Old World with anything like the facility with which those of the Old World are every day being naturalized here, this Pea-weevil does not begin to be as destructive there as it is at home.

THE FEMALE DEPOSITS HER EGGS ON THE OUTSIDE OF THE POD.

It is a very general remark that peas are "stung by the bug," and the impression prevails almost universally, not only among gardeners but with many entomologists, that the female weevil punctures and deposits her eggs *in* the pea in which the larva is to be nourished. It is a little singular that so many writers should have fallen into this error, for it is not only the accepted view amongst writers for the agricultural press, but has been adopted by many eminent entomologists, Taschenberg, Harris, and Dr. Boisduval being about the only authors who have rightly comprehended the true manner of egg-depositing. All this comes of course from one man's palming off the opinions of another as his own, and by his adopting such opinions, whether good or bad, without due credit. Even Noerdlinger in his "Kleinen Feunde der Landwirtschaft," though he cites the excellent and original observations of Taschenberg, feels himself called upon to doubt their correctness, and himself inclines to believe that the female may put her eggs in the pea. In Packard's Guide, the eggs are erroneously said to be laid on the blossoms.

The true natural history of the Pea-weevil may be thus briefly told. The beetles begin to appear as soon as our peas are in bloom, and when the young pods form, the female beetles gather upon them and deposit their eggs on any part whatever of the surface without attempting to insert the eggs within the pod.

The eggs, (Fig. 16,) are deep yellow, 0.035 inch long, three times as long as wide, fusiform, pointed in front, blunt behind, but larger anteriorly than posteriorly. They are fastened to the pod by some viscid fluid which dries white and glistens like silk. As the operation of depositing is only occasionally noticed during cloudy weather, we may safely assume that it takes place for the most part by night. If pea vines are carefully examined in this latitude any time during the month of June, the pods will often be found to have from one to fifteen or twenty such eggs upon them, and the black head of the future larva may frequently be noticed through the delicate shell.

[Fig. 16.]

As already stated, the eggs are deposited on all parts of the pod, and the mother beetle displays no particular sagacity in the number which she consigns to each, for I have often counted twice as many eggs as there were young peas, and the larvæ from some of these eggs would of course have to perish, as only one can be fully developed in each pea. The newly hatched larva is of a deep yellow color with a black head, and it makes a direct cut through the pod into the nearest pea, the hole soon filling up in the pod, and leaving but a mere speck, not so large as a pin-hole, in the pea. The larva feeds and grows apace and generally avoids the germ of the future sprout, perhaps because it is distasteful, so that most of the buggy peas will germinate as readily as those that have been untouched. When full grown this larva presents the appearance of Figure 17, *c*, (after Curtis) and with wonderful precognition of its future wants, eats a circular hole on one side of the pea, and leaves only the thin hull as a covering. It then retires and lines its cell with a thin and smooth layer of paste, pushing aside and entirely excluding all excrement, and in this cell it assumes the pupa state (Fig. 17, *d*, after Curtis,) and eventually becomes a beetle, which, when ready to issue,

[Fig. 17.]

has only to eat its way through the thin piece of the hull which the larva had left covering the hole. It has been proved that the beetle would die if it had not during its larval life prepared this passage way, for Ernest Menault asserts* that the beetle dies when the hole is pasted over with a piece of paper even thinner than the hull itself.

REMEDIES AND PREVENTIVES.

Sometimes, and especially when the summer has been hot and prolonged, many of the beetles will issue from the peas in the fall of the same year that they were born, but as a more general rule they remain in the peas during the winter and do not issue till new vines are growing. Thus many yet remain in the seed peas until they are planted and especially is this apt to be the case with such as are planted early. We see, therefore, how easily this insect may be introduced into districts previously free from it by the careless planting of buggy peas, for it has been demonstrated that the beetle issues as readily from peas planted in the earth as it does from those stored away in the bin. All peas intended for seed should be examined and it can very soon be determined whether or not they are infested. The thin covering over the hole of the peas that contain weevils, and which may be called the eye-spot, is generally somewhat discolored, and by this eye-spot those peas which ought not to be planted can soon be distinguished. Where this covering is off and the pea presents the appearance of Figure 15, *b*, there is little danger, for in that case the weevil has either left, or, if still within the pea, is usually dead. It would of course be tedious to carefully examine a large lot of peas, one by one, in order to separate those that are buggy, and the most expeditious way of separating the sound from the unsound, is to throw them into water, when the sound ones will mostly sink and the unsound swim.

There are, however, other and more certain means of preventing the injuries of this insect, and whenever agriculture shall have progressed to that point where by proper and thorough organization all the farmers of a county or of a district can, by vote, mutually agree to carry out a measure with determination and in unison, then this insect can soon be exterminated; for it is easy to perceive that such a result would be accomplished by combinedly ceasing to cultivate any peas at all for one single year! Until some such united action can be brought about, we shall never become entirely exempt from this insect's depredations, for no matter how sound the peas may be that I plant, my vines are sure to be more or less visited by the beetles as long as I have slovenly neighbors. Yet comparatively, my peas will always be enough better to well pay for the trouble, even under these circumstances.

**Insectes Nuisibles a l'Agriculture.*

As already hinted the Pea-weevil prefers a warm to a cold climate and its devastations are scarcely known in high latitudes. On this account the impression prevails that it does not occur in certain parts of Canada, and few persons are aware that it is nearly as bad, especially in Ontario, as it is with us. We are in the habit of sending to Canada for our seed peas, because we get them free from bugs; but the reason that their seedsmen have such a reputation is to be traced to their greater care in destroying the weevil and in sorting their seed rather than to any immunity from its ravages which their peas possess The following extract from a letter from Mr. Wm. Saunders, of London, Ontario, who, as secretary of the Ontario Fruit Growers' Association and as a prominent member of the Canadian Entomological Society, is as well posted, perhaps, as any one in the Dominion, will give some idea of its occurrence there:

The Pea-weevil I find prevails in all parts of Canada to a greater or lesser extent, from the Red River settlement to Quebec. In some places it is so numerous as to discourage farmers from attempting to grow peas at all, while other localities are but little troubled. About the neighborhood of Windsor (opposite Detroit) there are no peas grown worth speaking of; but 60 or 70 miles further east, towards London, they are an important crop, and about London, say within 30 or 40 miles, and as far east as Guelph and Hamilton, will include the chief district from which your western supplies are drawn.

During 1869 I grew a field of peas on my own farm. They produced a good crop, and although we have some of them on hand yet I have never observed a buggy one amongst them, although I have examined them several times. But it is rare to find them so free as that and something depends on the season. Last season the weather was very wet and the crop very light, and the dealers tell me now that there are scarcely any peas fit to ship in the country on account of the quantity of bugs they contain. They say that they always have to select for shipping, and while sending them as clean as possible they do not profess to send them entirely free from bugs.

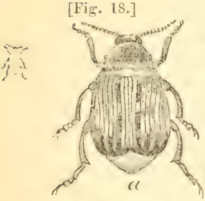
Our farmers here are perhaps a little more particular than yours about their seed. They will sometimes keep it over till the second year or else scald it before planting so as to destroy a large proportion of the bugs. The general opinion seems to be that if peas are sown late, say about the first of June, they will be almost free from bugs in any season, and some adopt this method, but it is not by any means a general thing, for should the weather set in very hot, as it sometimes does about that time, they would become somewhat dwarfed and the crop lessened. I have not heard of any one growing two crops in one season.

Many eminent seedsmen—Mr. Langdon for instance as I have been credibly informed—effectually kill the weevils by enclosing the peas in tight vessels along with camphor. The same object is attained by keeping peas two years, and taking care that the beetles do not escape before they die. Peas will grow well when kept for two years or even longer, but they should always be well dried so as not to mould. A good plan is to tie them up in bags and hang them in an airy place from the time they are gathered till about Christmas, and then in order that they may not become too dry, to put them into tighter vessels. To a certain extent sound peas may be obtained by planting late, for the period of egg-depositing is limited to about a month. Peas, as Mr. F. A. Nitchy of Jefferson City has demonstrated, may be planted in the central part of the State as late as the first of June, and by the time the plants from such late planted seed begin to bear pods, all the weevils will have died and disappeared. Wherever a second crop of peas can be grown the same year, this second crop will be entirely free from weevils, and though there seems to be some difficulty in producing a second crop in our State, on account of mildew, it is often done in higher latitudes. Choice lots of seed, if found to be infested when received from the seedsman, may be thrown into hot water for a minute or two, and the sprouting of the peas will be quickened, and most of the weevils, but not all, be killed. But whatever plan be adopted to obtain sound seed, it should be every man's aim, in duty to himself and to his neighbors, to plant none but bugless peas!

As natural checks, the Crow Black-bird is said to devour great numbers of the beetles in the spring, and according to Harris the Baltimore Oriole splits open the pods to get at the grubs contained in them.

THE GRAIN BRUCHUS—*Bruchus granarius*, Linn.

[Fig. 18.]



There is a weevil in Europe which is very common, attacking peas there as badly as our own Pea-weevil does in this country. It also infests beans and several other grains and seeds. It has on several occasions been imported with foreign seeds into this country, but very fortunately does not seem so far to have obtained a strong foothold. There is nothing to prevent its doing so, however, except the utmost vigilance on the part of those who import seeds, and it may at any time get scattered over the country by the distribution of infested seed from the Department of Agriculture, unless the authorities are ever watchful to prevent such a catastrophe. To enable a ready recognition of this weevil, I present an enlarged portrait of it at Figure 18. As will be noticed by that figure it bears a tolerably close resemblance to our own Pea-weevil, but it may always be distinguished from the latter species by the following characters as given by Curtis:—

It is in the first place a smaller insect, averaging but 0.14 inch while *pisi* averages nearly 0.20 inch. It is rather darker, there are two small white spots on the disk of the thorax, and the tooth at each side of the thorax is indistinct; the suture of the wing-covers forms a brown stripe, and the apical joint of the abdomen which protrudes beyond the wing-covers and which is otherwise known as the pygidium, is densely clothed with grayish pubescence, and shows in certain lights four minute dark dots, but no indication of the two large oval spots so characteristic of our Pea-weevil. The four basal joints of the antennæ and the front legs are reddish, and the inner spine of the hind shanks is prolonged.

It would be a sad misfortune to have this insect added to our list of injurious species, and it is no wonder that upon discovering specimens of our own Pea-weevil just disclosed in a parcel of peas which he had taken with him from America, the Swedish traveler Kalm was thrown into such a trepidation lest he should be the instrument of introducing so fatal an evil into his beloved country.

To give some idea of the habits of the Grain Bruchus, I quote the following account from Curtis's Farm Insects:—

"This species, which is everywhere abundant as early as February on the furze when it is in blossom, inhabiting also the flowers of various other plants in the beetle state, as the Rhubarb, Meadow-sweet (*Spiræa ulmaria*), etc., is a most destructive insect in our pea and bean fields, the larvæ feeding in the seeds and sometimes destroying more than half the crop. They are exceedingly abundant in some parts of Kent, where they often swarm at the end of May, and are occasionally found as late as August; indeed I killed one in November, imported with Russian beans, which had been alive since the end of September. It attempted to fly away in October; it then became torpid, but on warming it by a fire in the middle of November, it was as lively and active as in the height of summer, and I dare say would have lived through the winter.

"It is said that the female beetles select the finest peas to deposit their eggs in, and sometimes they infest crops to such an extent that they are eaten up by them, little more than the husk being left. The various kinds of beans are equally subject to their inroads; besides the long-pods I have alluded to, I have had broad Windsor beans sent to me containing these *Bruchi;* and Mr. C. Parsons transmitted me some horse-beans in the beginning of August, 1842, which were entirely destroyed by them. Mr. F. J. Graham showed me some seed beans which were inoculated by these beetles to a great extent, and some of them were alive in the seeds; yet to any one ignorant of the economy of this pest, there would not appear the slightest external indication of their operations. I also received from a gentleman residing in Norfolk a sample of seed beans from Russia, for winter sowing, a large proportion of which was perforated by this *Bruchus*.

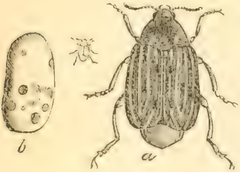
"It has already been intimated that as the beetles generally leave the germ uninjured, the vitality of infested seeds is not destroyed. I doubt, however, if they produce strong healthy plants; and from my own experience I have no doubt if peas and beans be sown containing the *Bruchus granarius*, that the beetles will hatch in the ground, and thus the cultivator will entail upon himself a succession of diseased pea and bean crops. Now to avoid this loss, the seed should be examined before sowing, when to an experienced eye the presence of these beetles will be discernible, where to a common observer they would appear sound and good. The maggots, when arrived at their full size, gnaw a circular hole to the husk or skin of the seed, whether pea or bean, and even cut around the inner surface which covers the aperture, so that a slight pressure from within will force this lid off;

these spots are of a different color to the rest of the seed, generally having a less opaque appearance, and often are of a duller tint; on picking off this little lid, a cavity will be found beneath containing either a maggot, pupa, or beetle."

THE AMERICAN BEAN-WEEVIL—*Bruchus fabæ*, N. sp.

This is another *Bruchus* which bids fair to out-do the celebrated Pea-weevil in its injurious work, and since it has but just made its appearance in our State as a bean destroyer, and is yet confined, so far as I am aware, to one single locality, I hope that the following account of it will have the effect to prevent its introduction into neighborhoods where it is now unknown, and thus keep it from spreading over the State. It appears to be a native American insect and doubtless fed originally on some kind of wild bean (*Phaseolus* or *Lathyrus*,) but it was first noticed in our cultivated beans about ten years ago, in Rhode Island, and has since at different times suddenly made its appearance in several other parts of the country. Maj. J. R. Muhleman, of Woodburn, Ills., informs me that while in South Carolina in 1863, some kind of weevil was often so common in the beans used by the army that before using such beans the men had to soak them, and afterwards lay them out to dry, in order to allow the beetles to escape. The weevil was doubtless the species under consideration, but there is no means of ascertaining from which part of the country the beans came.

[Fig. 19.]



Though already pretty well distributed in some of the Eastern States, especially in New York, it appears to be yet confined to certain localities in the Mississippi Valley. It has for instance, been quite troublesome of late years in Madison county, Ills., for I received last spring numerous specimens from Mr. Geo. W. Copley, of Alton, and am informed by Mr. J. F. Wielandy, of Jefferson City, Mo., that his father who is a resident of that county has been much troubled with it; yet it has never been heard of in other parts of the State. The only place in which I have, so far, found it in Missouri, is around Eureka, in St. Louis county, where it was first noticed in 1869, but where it occurred the present year in great numbers in two different fields of a white pole bean. It occurs in some parts of Pennsylvania, and is quite common in New York, and to illustrate the amount of damage it is capable of doing, I make room for the following letter, which was received in November, 1870, from Mr. James Angus, of West Farms, N. Y., and which refers to this insect:

I enclose you a sample of beans to show you how thoroughly and effectually this little vagabond is plying his time immemorial avocations in the bean-patches in this quarter. Five or six years ago I had occasion to call on a neighbor, and in passing through the barn he pointed out to me a heap of threshed beans, on the floor, of the Early Mohawk variety, which he said had been destroyed by bugs getting into them since they were threshed. (?) A casual inspection showed that they were destroyed sure enough. At least one-half of them were as badly infested as the sample I send you, but as I pointed out to him, the damage which was now an accomplished fact, had been commenced during the growing season, and the "bugs" were now leaving the beans instead of entering them.

Next season I found a few among my own beans, and they have been on the increase ever since; and this year my Yellow Six Week variety are nearly as bad as my neighbors referred to above. They are nearly as bad this year on a pole variety, the "Dutch Case Knife," as they are on the low growing ones. The small black bush variety, however seems to have escaped them. If some check is not put to their ravages soon, the culture of beans will have to be given up here.

In a short article on this weevil, published by Mr. S. S. Rathvon, in the *American Entomologist*, (Vol. II, pages 118-119,) that gentleman gives the following account of its appearance in his neighborhood:

My specimens evolved in the months of June, July, August and September, from three varieties of the domestic bean (*Phaseolus*,) commonly called "Cranberry," the "Agricultural," and the "Wrens-egg" beans, obtained from Mrs. P. C. Gibbons, Enterprise, Lancaster county, Pa. * * * * I have not yet heard of this insect being found in any other locality in Lancaster county than the one above named. The tenant from whom Mrs. Gibbons received these infested beans has been engaged in the bean culture for twenty-five years on the same farm, and never noticed these weevils until within the last two or three years, and only last year did their destructive character become conspicuously apparent; for out of a small sack of seed-beans hung away, containing less than two quarts, she gathered nearly a teacup-full of the weevils at planting time, in the early part of June, and had all been infested as those were which she brought to me, she could have easily doubled the quantity. About five years ago Mrs. Gibbons received some seed-beans of the "Cranberry" variety, from Nantucket, Mass., and prior to that, she also received some from the Agricultural Department of the Patent Office, and with the one or the other of these, the impression is that the weevils must have been received.

If, as I have supposed (and by perusing what is printed below in small type, the reader will see that no other conclusion can be drawn), this weevil is indigenous; it may possibly occur over large tracts of our country, though the fact that, till a few years ago, it had never been collected by any American entomologist, would strongly intimate that, in what may be termed its wild state, it was quite rare and had a limited range. But even if it should occur in this wild state more generally through the country than the facts would lead us to believe, there is nevertheless more danger of its being introduced into a bean field hitherto exempt by the planting of infested cultivated beans, than by its spreading from the wild food. And if once a few buggy beans are planted, they will in a few years contaminate the other beans cultivated in the neighborhood, so that the man who year after year grows his own seed will suffer as much as the man who originally introduces the weevils from afar.

Except in being smaller, the larva and pupa of this weevil have a close resemblance to those of the Pea-weevil, and its habits are very similar, with the exception that the female deposits a greater number of eggs on a single pod, so that sometimes over a dozen larvæ enter a single bean. I have counted as many as fourteen in one small bean, and the space required for each individual to develop is not much more than sufficient to snugly contain the beetle. The little spot where the Pea-weevil entered can always be detected even in the dry pea, but in the bean these points of entrance become almost entirely obliterated. The cell in which the transformations take place is more perfect and smooth, and the lining is easily distinguished from the meat of the bean by its being more white and opaque. The excrement is yellow or darker than the meat, and even where a bean is so badly infested that the inside is entirely reduced to this excrementitious powder, each larva, before transforming, manages to form for itself a complete cell, which separates it from the rest of its brethren. The eye-spot, as in the pea, is perfectly circular and quite transparent in white-skinned varieties, so that infested beans of this kind are easily distinguished by the bluish-black spots which they exhibit (Fig. 19, *b*). Dark beans when infested are not so easily distinguished.

I have always found the germ either untouched or but partially devoured even in the worst infested beans, so that when but two or three weevils inhabit a bean, it would doubtless grow; but where the meat is entirely destroyed, as it often is, the bean would hardly grow though the germ remained intact, and it would certainly not produce a vigorous plant.

Many of the beetles are perfected in the fall, but many of them not till the following spring, so that there is the same danger of introducing them in seed-beans, as in the case of the Pea-weevil. The remedies and preventives given in the former case will of course apply equally well in this, and I hope that every bean-grower in Missouri who reads this article will make some effort to keep the scourge out of his own neighborhood, by urging upon others, at the Farmers' Club, or at the meetings of any local societies, the necessity of sowing only sound seed, and of thoroughly destroying any that may be received from abroad and found buggy.

Regarding the proper nomenclature of our Bean-weevil, there has been some confusion, and though it has heretofore been considered by several eminent entomologists as the *Bruchus obsoletus* of Say, and I have heretofore, upon insufficient grounds, referred it to that species myself, it nevertheless turns out to be undescribed. In Europe, besides the Grain Bruchus which I just treated of, there are several other species belonging to the same genus which attack beans; but our insect differs from all of them and especially from the Grain Bruchus, to which it has been erroneously referred by Dr. A. S. Packard, Jr.* If it were the imported Grain Bruchus, our peas and some other grains would probably suffer as much from its attacks as our beans, because that species infests peas and other seeds in Europe; but in reality we have no more reason to believe that our Bean-weevil will attack our peas than that the Pea-weevil will attack our beans.

The general color of our Bean-weevil is tawny-gray, the ground-color being dark and the whole body covered with a grayish pubescence which inclines to yellow or fulvous, or wears a slight moss-green hue, and is shaded as in Figure 19, *a*. It is but half the size of the Pea-weevil and has the four or five basal joints and the terminal joint of the antennæ, and the legs, with the exception of the lower and inner part of the hind thighs, reddish-brown.

Bruchus fabæ N. Sp. (Fig. 19,)—General color tawny-gray with more or less dull yellowish. *Body* black tinged with brown and with dull yellowish pubescence, the pygidium and sides of abdomen almost always brownish. *Head* dull yellowish-gray with the jaws dark brown and palpi black; antennæ not deeply serrate in ♀, more so in ♂; dark brown or black with usually 5, sometimes only 4, sometimes 4 and part of 5 basal joints, and with the terminal joint, more or less distinctly rufous, or testaceous, the color being so slight in some specimens as scarcely to contrast at all with the darker joints. *Thorax* narrowed before, immaculate, but with the pubescence almost always exhibiting a single pale medio-dorsal line, sometimes three dorsal lines, more rarely a transverse line in addition, and still more rarely (two specimens) forming a large dark, almost black patch each side, leaving a median stripe and the extreme borders pale and thus approaching closely to *erythrocerus* Dej.; base with the edges almost angulated; central lobe almost truncate and with a short longitudinal deeply impressed median line; no lateral notch; scutel concolorous and quadrate with the hind edge more or less notched. *Elytra* with the interstitial lines having a slight appearance of alternating transversely with dull yellowish and dusky; so slight however that in most of the specimens it can hardly be traced: the dark shadings form a spot on each shoulder and three transverse bands tolerably distinct in some, almost obsolete in others, the intermediate row being the most persistent and conspicuous: between these dark transverse rows the interstices are alternately more or less pale, especially on the middle of the 3rd interstitial lines. *Legs* covered with grayish pubescence, and with the tibiæ and tarsi, especially of first and second pair, reddish-brown; the hind thighs usually somewhat darker, becoming black below and inside, and with a tolerably long black spine followed by two very minute ones. Length 0.09—0.14 inch. Described from 40 specimens all bred from different kinds of beans. Hundreds of others examined.

This insect has been for several years ticketed in some of the Eastern collections by the name of *B. fabæ*, or else, what is worse, the corruption of it, *fabi*. The former name has been disseminated by my friend F. G. Sanborn of Boston, Massachusetts, who says that he received the weevil thus named, together with beans attacked by it, in the year 1862 from Rhode Island. The name was credited to Fabricius, but I can find no notice in any of the works I possess of any European *Bruchus fabæ*, and several of my Eastern correspondents who have access to large libraries have been unable to find any description or allusion to a species by that name. Dr LeConte has given it the MS name of *varicornis* but as his description will not appear perhaps for years to come and as no comprehensive description has yet been published, I have deemed it advisable to dispel in a measure the confusion that surrounds the nomenclature of the species. There is need of a description of so injurious an insect, and as *fabæ* is not preoccupied I adopt the name because it is entirely appropriate and because it is more easily rendered into terse popular language that *varicornis*. †

* Injurious insects new and little known, pp. 19–21.

† No one can have a greater regard than I have, for the work of our great Coleopterist, Dr. LeConte, who is justly looked up to as our authority in his specialty; and for no other reason than the one given above would I venture to disregard even one of his manuscript names. Were he now at home, I should have corresponded with him on the subject, and I feel satisfied that he would have sanctioned this course. These remarks are prompted by the fact that certain entomolo-

It resembles most closely of any other species which I have seen, the *B. erythrocerus*, Dej. which, however, is smaller, and differs in having a narrower thorax which has light sides and a dark, broad dorsal stripe divided down the middle by a pale narrow line: *erythrocerus* is further distinguished by the antennæ being entirely testaceous and the hind thighs more swollen.

From *obsoletus* Say, *fabæ* differs materially: *obsoletus* is a smaller species, dark gray, with the antennæ all dark, the pygidium not rufous, the thorax with a perceptibly darker dorsal shade so that the sides appear more cinereous, a white scutel, and each interstitial line of the elytra with a slight appearance of alternating whitish and dusky along its whole length; for though there is nothing in Say's language to indicate whether it is the interstitial lines that alternate transversely, whitish and dusky, or each line that so alternates longitudinally, I find from an examination of a specimen in the Walsh collection, that the latter is the case, and so much so that the insect almost appears speckled. The two species differ both in size and color, though, as Say's description is short and imperfect it is not surprising that *fabæ* should have been referred to it.

From the European bean-feeding *Br. flavimanus* (which is apparently either a clerical error for, or a synonym of *Br. rufimanus*, Schœnh.) as described by Curtis, it differs notably; as it does likewise from their *Br. serratus*, Ill., which also attacks beans.

Dr. LeConte, according to Mr. Rathvon, was inclined to consider this insect the *obsoletus* of Say, from the fact that in specimens which the latter gentleman sent him, the antennæ were not varied as in his MS. *varicornis*, but uniformly black. A few specimens which Mr. Rathvon sent me nearly two years ago, taken from the same lot as were those which he forwarded to Dr. LeConte, were singularly enough, all decapitated but two; and these two showed the varied antennæ. These specimens had all been kept in alcohol, and I am greatly inclined to believe that the uniformly dark appearance of the antennæ that was noticed by LeConte was the effect of the alcohol on those which naturally had the rufous joints but faintly indicated. At all events, though Mr. Rathvon tells me that he found a small proportion of beetles with dark antennæ, after examining, at my suggestion, over two hundred specimens that had thus been kept in alcohol; yet from over one hundred specimens which he had the kindness to send me, I only find (after thoroughly drying them) three with the terminal joint really as dark as the subterminal, and not a single one in which the rufous basal joints cannot be more or less distinctly traced.

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gists have objected to isolated descriptions of insects, on the plea that they cause confusion and an unnecessary synonymy in our nomenclature. There is, in fact, a certain class of persons—and they have been aptly termed closet-entomologists—who manifest a superlative contempt for anything that does not appear in the transactions or publications of some scientific society; and they even claim that the descriptions which have appeared in State Entomological Reports are invalid and should be disregarded. The descriptions of Dr. Fitch, and many of those of the late Mr. Walsh, and my own, would of course come under this head. It is a little significant, however, that the very persons who manifest such a contempt for scientific work, whenever it is combined with the practically useful, are the very ones who indulge in the fatal monomania for grinding out new species from the mere comparison of a few more or less damaged specimens of the perfect insects, obtained nobody knows how, when or where; and without even the slightest knowledge of the larval and pupal history and the general habits of the so-called species. They make species out of the slightest individual variation, and even erect genera upon a slight individual difference in the size or shape of the wing. So baseless a system must necessarily be fraught with great scientific untruthfulness, and is well calculated to disgust the student who endeavors to rightly interpret the significances in Nature. An immense number of the published descriptions in the Class of insects in this country are based upon the simple examination of solitary specimens of the perfect insects, without the fact being mentioned, and are therefore not in any true sense of the term descriptions of species, but mere descriptions of individuals. The few men whose sole ambition seems to be to attach their names to as many of these so-called species as possible, are the ones who are most inclined to sneer at, and treat lightly the honest work of more practical men—forgetting that science does not consist of mere classification and orderly arrangement, but that she wears a nobler mien when applied to penetrating and comprehensive search after Nature's truths.

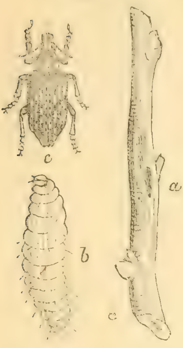
A truth is equally scientific, whether published in a plain, practical work, or in the drier pages of the transactions of some august scientific body; and so far as the science of entomology is concerned, it will certainly be more advanced by the full and comprehensive description of a species, albeit such description be clothed in plain terms and published in a popular work, than by a less complete and more confused description, in the transactions of an Entomological Society; and provided it is published in a work essentially entomological, the monographer will certainly prefer the former to the latter. In the past, science belonged to the few, and was always paraded before the world in as unattractive and technical a form as possible. To-day she is fast becoming the property of the multitude, and should be popularized as much as possible; for it is folly to suppose, as some men do, that in science "popular" and "inaccurate" are synonymous terms, simply because some writers have failed to combine the scientifically accurate with the popular and practical.

The entomologist who occupies himself with the habits of insects, cannot well become a systematist, and would far sooner accurately describe the hitherto unknown habits and transformations of a single common species, than describe a dozen new ones. He may have hundreds of new species in his cabinet; but these he prefers to turn over to the specialist, whose work he fully appreciates and whose aid he must often seek. When, however, in the course of his work, he is obliged to publish an isolated description, the specialist proper should certainly not depreciate his labor, providing it is well performed.

THE NEW YORK WEEVIL—*Ithycerus noveboracensis*, Forster.

The large gray beetle represented at *c*, in the accompanying cut often does considerable damage to fruit trees, and I continually receive it every spring by persons who desire to know more of its habits. It kills the twig by gnawing off the tender bark, in the early part of the season before the buds have put out, and later in the year it destroys the tender shoots which start out from old wood, by entirely devouring them. It eats out the buds and will also frequently gnaw off the leaves at the base of the stem, after they have expanded. It attacks, by preference, the tender growth of the Apple, though it will also make free with that of Peach, Plum, Pear and Cherry, and probably of other fruit as well as forest trees. It is the largest snout-beetle which occurs in our State. and with the rest of the species belonging to the same genus (*Ithycerus*=straight-horn) it is distinguished from most of the other snout-beetles by the antennæ or feelers being straight instead of elbowed or flail-shaped as they are in the common Plum Curculio, for instance. The specific name *noveboracensis* which means "of New York" was given to this beetle just 100 years ago by Forster, doubtless because he received his specimens from New York. But like many other insects which have been honored with the name of some Eastern State, it is far more common in the Mississippi Valley than it is in the the State of New York, it scarcely being known as an injurious insect in the East. It was subsequently described as *Pachyrhynchus Schœnherri* by Mr. Kirby. The general color of the beetle is ash-gray, marked with black as in the cut (Fig. 20, *c*), and with the scutel or small semi-circular space immediately behind the thorax, between the wings, of a yellowish color. Its larval habits were for a long time unknown, but two years ago I ascertained that it breeds in the twigs and tender branches of the Bur oak, and have good reason to believe that it also breeds in those of the Pignut hickory. The female in depositing, first makes a longitudinal excavation with her jaws (Fig. 20, *a*) eating upwards under the bark towards the end of the branch, and afterwards turns round to thrust her egg in the excavation. The larva, (Fig. 20, *b*) hatching from the egg is of the usual pale yellow color with a tawny head. I have watched the whole operation of depositing, and, returning to the punctured twig a few days after the operation was performed, have cut out the young larva; but I do not know how long a time the larva needs to come to its growth, nor whether it undergoes its transformations within the branch, or leaves it for this purpose to enter the ground; though the former hypothesis is the more likely.

[Fig. 20.]



This insect is more active at night than during the day, and is often jarred down upon the sheet or the Curculio-catcher, for it falls about as readily as the Plum Curculio.

The destructive pear blight, otherwise known as fire-blight, has been attributed to a peculiar poisonous fluid which this beetle secretes and with which it poisons the wood.* I have never noticed any such secretion, and feel quite convinced that it has nothing to do with the real pear blight (and there are more than one kind) which is very justly considered by the most eminent horticulturists of the land to be of fungoid rather than insect origin. It is quite probable that the beetle secretes some such fluid which causes a sort of blight, because several bark-boring and wood-boring beetles are known to produce such an effect; but this insect-blight must not be confounded with the far more subtle and destructive Pear Blight, so called.

THE IMBRICATED SNOUT-BEETLE—*Epicærus imbricatus*, Say.

This is another insect, which is quite frequently met with on our different fruit trees, doing considerable injury to apple and cherry trees and gooseberry bushes, by gnawing the twigs and fruit. Its natural history is, however, a sealed book, and I introduce it at present more to draw the attention of orchardists to this fact than to give any information with regard to it. The beetle is a native of the more Western States and is found much more commonly in the western part of the State, in Iowa, Kansas, and towards the mountains than it is on the eastern side of the great Father of Waters.

[Fig. 21.]

The general color is a dull silvery-white with brown markings as in the figure (Fig. 21), which are sometimes dark and distinct, and at others almost obsolete. Indeed the species is so variable that it has received no less than four distinct names, *i. e.* four distinct species have been fabricated out of one.†

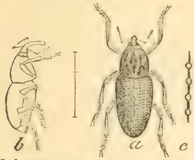
*See a communication from H. H. Babcock, of Chicago, in the *Am. Entomologist and Botanist*, Vol. II, p. 176.

†There can be no doubt of this, for the range of variation is so great that specimens agreeing in every respect with *imbricatus*, *fornudolosus*, *vadosus* and *fallax*, are to be met with in very limited localities; and both Dr. LeConte and Mr. Walsh were of opinion that these four so-called species were but varieties.

THE CORN SPHENOPHORUS—*Sphenophorus zeæ*, Walsh.

In the last number of the *Practical Entomologist*, Mr. Walsh gave the first account of a weevil which in certain years does great damage to the corn crop by puncturing the young plant near the ground, and riddling it with holes of about the size that an ordinary pin would make. They may even be found under ground attached firmly to the stalk, and when numerous enough the plant always dies.

[Fig. 22.]



b *a* *c*

The color of the beetle is brown-black or black, often obscured by yellowish or grayish matter adhering to, and filling up the hollow punctures. Figure 22 gives a good illustration of it, *a* showing a shaded back view, *b* an outline side view, and *c* showing the manner in which the wing-covers are punctured. The original description as given by Mr. Walsh will be found below.

In the spring of 1868, Mr. L. V. Smith, of Geneva, Ontario county, N. Y., sent me numerous specimens; and I have often found it in great numbers on the lake-beach at Chicago, though it does not seem to be common in our own State. But it is well that corn-growers be made familiar with its appearance.

The larval history of this weevil is unknown, but there seems good reason to believe that it breeds in rotting and moist wood, situated in places where it is constantly washed by the water; for the beetles, with others belonging to the same genus are found in such situations and in decayed logs floating in swamps. If this supposition be the correct one—and the fact that it has been injurious only in the immediate neighborhood of rivers and lakes adds great weight to such a supposition—then this weevil will not be likely to multiply unduly where there are not large bodies of water.

"SPENOPHORUS ZEÆ, new species? Color black, often obscured by yellowish matter adhering to the hollow places, which, however, can be partially washed off. Head finely punctured towards the base, with a large dilated puncture between the eyes above. Snout one-third as long as the body, of uniform diameter, as fine as a stout horse-hair, and curved downwards. Before the middle of the thorax a polished diamond-shaped space, prolonged in a short line in front and in a long line behind; and on each side of this an irregularly defined polished space, somewhat in the form of an inverted Y; the rest of thorax occupied by very large punctures, which fade into finer and sparser ones on the polished spaces. Wing-cases with rows of still larger punctures, placed very wide apart in the usual grooves or striæ; the sutural interstice, that between the 2nd and 3rd striæ, and that between the 4th and 5th striæ wider than the rest, elevated, and occupied by very fine punctures; a small elongate-oval polished spot on the shoulder and another near the tip of the wing-case. Beneath, polished, and with punctures as large as those of the thorax.—Length about three-tenths of an inch, exclusive of the snout. Comes very near *Sphenophorus truncatus* Say, but the snout is not "attenuated at tip" and has no "elongated groove at base above;" and moreover, nothing is said in the description of that species of the very large and conspicuous punctures, found in the elytral striæ of our species."

THE COCKLEBUR SPHENOPHORUS—*Sphenophorus pulchellus*, Schœnherr.

[Fig. 23.]

In closing this chapter on snout-beetles I introduce this species (Fig. 23, *a* shaded back view; *b* outline side-view,) not that it is injurious, but because it belongs to the same genus, and is closely allied to the preceding insect; and because its larval habits, which are now given for the first time, may lead us more readily to discover those of its more injurious ally.

The color of this beetle above, is of a deep brick-red inclining to blood-red, often with a tinge of orange, and it is marked with black as in the figure, the whole underside being also black. The larva bores the stalks of the common cocklebur (*Xanthium strumarium*,) and differs from most other snout-beetle larva in having a dark mahogony-brown head, and in the anal joint being slantingly truncated and furnished with fuscous elevations which give rise to short stiff bristles. It transforms in the fall of the year within the stem and issues as a beetle about the end of September.*

Of our other N. A. snout-beetles may be mentioned as especially injurious the Grape Curculio (*Caliodes inæqualis*, Say), Grape-cane Curculio (*Baridius sesostris*, Lec.) Potato-stalk weevil (*Baridius trinotatus*, Say), the different nut-weevils (genus *Balaninus*), the Grain-weevil (*Sitophilus granarius*, Linn.), the White-pine weevil (*Pissodes strobi*, Peck), and the Cranberry-weevil (*Anthonomus suturalis*, Lec.) The first three have already been treated of in my first Report, the nut-weevils will form the subject of a future article, and the others have either been fully treated of in standard works or are not particularly injurious in Missouri.

*This insect seems to differ from 13-*punctatus*, Say, in absolutely nothing but in having a large black patch at the tip of the elytra instead of two spots. I have bred four specimens from cocklebur, and they are all tolerably constant in the characters accorded to *pulchellus*. But I am strongly of opinion that we have to deal here with but one species, and that with a sufficiently large series, the dividing line could not be drawn. At all events 13-*punctatus* is very variable in the size of its spots, and the greatest variation occurs in these two at the tip of the elytra, while Say describes and figures a variety of his 13-*punctatus* which is singularly intermediate between the two species. In three specimens of 13-*punctatus* in my cabinet, the two posterior spots are so large that they almost meet, while in some specimens they are not larger than the other elytral spots.

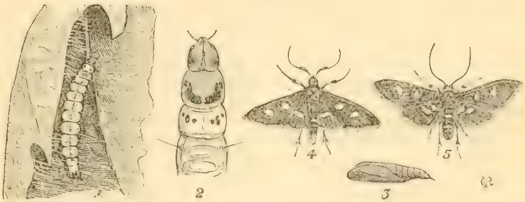
INSECTS INJURIOUS TO THE GRAPE-VINE.

The following articles under this head are a continuation of the series began in my first and continued in my second Report, and I shall continue the series until all the insects of any note, which affect the Grape-vine, shall be treated of.

THE GRAPE LEAF-FOLDER—*Desmia maculalis*, Westw.

(Lepidoptera, Asopidæ.)

[Fig. 24.]



The subject of this sketch has long been known to depredate on the leaves of the Grape-vine in many widely separated parts of North America. It is not uncommon in Canada West, and is found in the extreme southern parts of Georgia. It appears to be far more injurious, however, in the intermediate country, or between latitude 35° and 40°, than in any other sections, and in Southern Illinois and Central Missouri proves more or less injurious every year. It was first described and named by Westwood,* who erected, for it, the genus *Desmia*.

The genus is characterized by the elbowed or knotted appearance of the ♂ antennæ, in contrast with the smooth, thread-like ♀ antennæ; the maxillary palpi are not visible, while the compressed and feathery labial palpi are recurved against the eyes, and reach almost to their summit; the body extends beyond the hind wings.

The moth of the Grape Leaf-folder is a very pretty little thing, expanding on an average almost an inch, with a length of body of about one-third of an inch. It is conspicuously marked, and the sexes differ sufficiently to have given rise to two names, the female having been named *Botys bicolor*. The color is black with an opalescent reflection, and the under surface differs only from the upper in being less bright; all the wings are bordered with white. The

* Mag. Zool., par M. Guérin, 1831; pl. 2.

† Mr. Glover, in the Agricultural Report for 1854, p. 79, says that the male has a semi-lunar mark of white on the outside of each spot, which in his figure, pl. 6, ibid., is very distinct. In dozens of specimens bred in Illinois and Missouri no such mark appears, though there is an apparent coincident shade, barely distinguished from the black ground-color, on the outside of each spot in both male and female.

front wings of both sexes are each furnished with two white spots;† but while in the male (Fig. 24, 4) there is but one large spot on the hind wings, in the female (Fig. 24, 5) this spot is invariably more or less constricted in the middle, especially above, and is often entirely divided into two distinct spots. The body of the male has but one distinct transverse band, and a longitudinal white dash at its extremity superiorly, while that of the female has two white bands. The antennæ, as already stated, are still more characteristic, those of the male being elbowed and thickened near the middle, while those of the female are simple and thread-like.

There are two broods in this latitude—and probably three farther south—during the year; the first moths appearing in June, the second in August, and the worms produced from these last hibernating in the chrysalis state. The eggs are scattered in small patches over the vines, and the worms are found of all sizes at the same time. These last change to chrysalids in 24 to 30 days from hatching, and give forth the moths in about a week afterwards.

The worm (Fig. 24, 1) folds rather than rolls the leaf, by fastening two portions together by its silken threads; and for this reason, in contradistinction to the many leaf-rollers, may be popularly known as the "Grape Leaf-folder." It is of a glass-green color,* and very active, wriggling, jumping and jerking either way at every touch. The head and thoracic segments are marked as at Figure 24, 2. If let alone, these worms will soon defoliate a vine, and the best method of destroying them is by crushing suddenly within the leaf, with both hands. To prevent their appearance, however, requires far less trouble. The chrysalis is formed within the fold of the leaf, and by going over the vineyard in October, or any time before the leaves fall, and carefully plucking and destroying all those that are folded and crumpled, the supply for the following year will be cut off. This should be done collectively to be positively effectual, for the utmost vigilance will avail but little if one is surrounded with slovenly neighbors.

I believe this insect shows no preference for any particular kind of grape-vine, having found it on well nigh all the cultivated as well as the wild varieties. Its natural enemies consist of spiders, wasps, and a small undescribed species of *Tachina*-fly which I have ascertained to infest it in the larva state, and to which I have given the MS. name of *desmiæ*. There is every reason to believe that it is also attacked by a small clay-yellow beetle, the Grape-vine Colaspis

* I subjoin a description of this worm, as first given by me in the Prairie Farmer Annual for 1868. Average length, 0.80. Largest on abdominal joints, and tapering thence slightly each way. Color glass-green, always darker above than below. A narrow darker dorsal line, with each joint swollen into two transverse wrinkles. Laterally paler or yellowish, and a large and distinct piliferous spot on each joint, with others scarcely visible with a lens. Head fulvous, polished, horizontal, with two small eyespots and two larger dark patches. Joint 1 of the same color, and marked as in Figure 24, 2. Joint 2 has two small spots, with an intermediate larger one, on each side. Legs yellowish. Acquires a carneous or pink tint before changing to chrysalis, which latter is of the normal color, size and form of Figure 24, 3, and has at the tail several very minute curved hooks, joining and forming into a point.

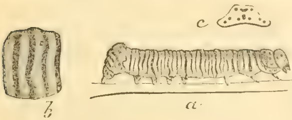
(*Colaspis flavida*, Say,) which is described further on, and which, though a vegetable feeder, may often be found in the fold of the leaf in company with some shrunken, half-dead worm.

THE GRAPE-VINE EPIMENIS.—*Psychomorpha epimenis*, Drury.

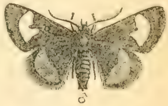
(Lepidoptera Zygænidæ.)

Under the head of "Blue Caterpillars of the Vine," an account was given in my last Report (pp. 83–5) of the Pearl Wood Nymph, (*Eudryas unio*, Huebner), and of what I thought there was good reason to believe was its larva, namely, the smaller of the blue caterpillars (Fig. 25, *a* full grown caterpillar; *b* enlarged side view of one of the joints; *c* enlarged hump on the 11th joint). I have since been able to decide definitely as to the character of this larva, having bred numerous specimens to the perfect state. It turns out to be an entirely different insect to what I had conjectured, and produces a beautiful little moth (Fig. 26), which may be known to the grape-grower as the Grape-vine Epimenis.

[Fig. 25.]



[Fig. 26.]



This moth is most strikingly marked and bears no resemblance whatever to the Pearl Wood Nymph. Its color is deep velvety-black with a broad irregularly lunate white patch across the outer third of the front wings, and a somewhat larger, more regular patch of orange-red or brick-red on the hind wings. The underside is similarly marked, but that of the front wings is less velvety with two additional white spots inside near the costa, the outer one generally, and sometimes both of them, connected with the broad white patch. Especially is this the case in the males; the wing appearing to have a large triangular white patch with two quadrate black spots in it connected with the costa. The wings are beautifully tinselled with steel-blue, or purplish scales, which form a narrow band near the outer margin of each and appear more or less distinctly on the basal half of the front wings. On the under side the steel-blue is especially conspicuous on the costa and hind border of the hind wings. In old specimens the scales get much rubbed off and the general color appears duller and more brown. The antennæ of the female are thread-like and with alternate black and white scales. Those of the male are beautifully and broadly toothed on two sides, or bi-pectinate, and he is furthermore distinguished from the female by the more uniform diameter of his abdomen which is slightly tufted and squarely cut off at the apex.

A full account was given of the larva in the article already referred to, and the proper remedy for its injuries suggested, so that I shall simply add below a technical description of it. Its habit of boring into some substances to prepare for the change to pupa is inveterate, and it always neatly covers up the orifice so that it is difficult to detect. I have had over a dozen of them enter a single cork but 1¼ inches in diameter and about an inch deep; and such a cork, if given during May of one year to an uninitiated person, with instructions to keep it in a glass vessel, will cause much surprise and interest the following March when the moths will begin to issue from it.

Dr. Melsheimer* wrote to Dr. Harris on the 28th of February, 1840, that he had bred this moth from the larva, and rightly states that recent specimens are not brown, and that the larva is a half looper; but he does not mention its food-plant. Dr. Packard,† who does not mention the sexual differences, quotes Harris as stating on the authority of Abbott, that the larva feeds on the wild Trumpet-creeper (*Bignonia radicans*) in Georgia. But no one has heretofore mentioned its Grape-vine feeding propensities, and it is consequently now added for the first time to our list of Grape-vine depredators, and there are four instead of three bluish caterpillars, all bearing a close general resemblance, which feed upon that plant. They all occur in Missouri, but the present species is far more numerous and destructive than the other three put together. I have now described three of them, and shown wherein they differ from one another, and the fourth, namely, the larva of the Pearl Wood Nymph, is said by Dr. Fitch to so closly resemble that of the Beautiful Wood Nymph that we know not yet whether there are any distinguishing characteristics between them.

PSYCHOMORPHA EPIMENIS, Drury—*Larva.*—General appearance bluish. The ground-color is however pure white, and the apparent bluish cast is entirely owing to the ocular delusion produced by the white with the transverse black bands as in *Alypia octomaculata.* Transversely banded with four black stripes to each joint, the third and fourth being usually rather wider apart than the other two, and diverging at the lower sides where they make room for two more or less conspicuous dark spots placed one below the other; the third on some of the middle joints is frequently broken, with an anterior curve, just above stigmata, and on joints 2 and 3 it is twice as thick as the rest. Cervical shield, hump on joint 11, anal plate, legs and venter, dull pale orange. Joint 1 with about 14 large shiny piliferous black spots, 8 of which form two rows on the cervical shield (those in the anterior row being largest and farthest apart,) and six of which are lateral, namely, three each side, with more or less distinct dusky marks between and in front of them. The spots on the hump are usually placed as at Figure 26, *c*, but vary very much, though the four principal ones on the top are generally placed in a square. The anal plate is marked with 8 such spots, very much as in the cervical shield, but smaller. The tips of the thoracic legs are black and the other legs and venter are also spotted. Head gamboge-yellow, inclining to orange, with 8 principal and other minor black piliferous spots. The ordinary piliferous spots are small, and except two dorsal ones which are in the white space between the second and third band, they are not easily detected. The stigmata are also quite small and round. The abdominal prolegs de-

* Harr. Corr., p. 111.
† Guide, etc., p. 281.

crease in size from the last to the first pair, and the larva curves the thoracic joints and is a half-looper, especially when young. Average length about one inch. Described from numerous specimens.

Chrysalis.—Average length 0.37 inch; reddish-brown; rugose, especially on dorsum of abdominal joints, but distinguished principally by the truncated apex, which has a large horizontally compressed ear-like horny projection at each upper and outer edge.

THE GRAPE-VINE PLUME—*Pterophorus periscelidactylus*, Fitch.

(Lepidoptera, Alucitidæ.)

In my first Report a short account has already been given of this insect, but as it was very numerous last spring, and as I had good opportunities of making further observations, I have concluded, by aid of the accompanying figure, to give a more complete account of it.

[Fig. 27.]

In the earlier published Proceedings of our State Horticultural Society reference is occasionally made to "small grey or green worms which feed on the young leaves before blossoming,"* without any definite name being given to them. Husmann, in his "Grapes and Wine," (p. 80) mentions similar worms, and I have little doubt but that the insect referred to is the little Plume we are now considering.

Just about the time that the third bunch of grapes, on a given shoot, is developing, many of the leaves, and especially those at the extremity of the shoot, are found fastened together more or less closely, but generally so as to form a hollow ball. These leaves are fastened by a fine white silk, and upon opening the mass and separating the leaves, one of two caterpillars will generally be found in the retreat. I say one of two, because the retreat made by the smallest of the Blue Caterpillars of the Vine, namely, the larva of the Grape-vine Epimenis (Fig. 26, *a*) which we have just treated of, so closely resembles that of the Grape-vine Plume under consideration, that until the leaves are separated it is almost impossible to tell which larva will be found. Both occur at the same time of year, and both were more destructive than usual the past season in the vicinity of St. Louis. In an ordinary season they do not draw together the tips of the shoots till after the third bunch of grapes is formed, and in devouring the terminal bud and leaves, they do little more than assist the vineyardist in the pruning

* Proceedings for 1860, p. 58, and 1861–2, p. 77.

which he would soon have to give. They act, indeed, as Nature's pruning-knives. But the late and severe frost which killed the first buds last April, so retarded the growth of the vines that the worms were out in force before the third bunch had fully formed, and this bunch was consequently included in the fold made by these worms, and destroyed.

The larva of the Grape-vine Plume invariably hatches soon after the leaves begin to expand; and though it is very generally called the Leaf-folder, it must not be confounded with the true Leaf-folder, which was just now described, and which does its principal damage later in the season. At first the larva of our Plume is smooth and almost destitute of hairs, but after each moult the hairs become more perceptible, and when full grown the larva appears as at Figure 27, *a*, the hairs arising from a transverse row of warts, each joint having four above and six below the breathing-pores * (see Fig. 27, *c*). After feeding for about three weeks, our little worm fastens itself securely by the hind legs to the underside of some leaf or other object, and, casting its hairy skin, transforms to the pupa state. This pupa (Fig. 27, *b*), with the lower part of the three or four terminal joints attached to a little silk previously spun by the worm, hangs at a slant of about 40°. It is of peculiar and characteristic form, being ridged and angular, with numerous projections, and having remnants of the larval warts; it is obliquely truncated at the head, but is chiefly distinguished by two compressed sharp-pointed horns, one of which is enlarged at Figure 27, *c*, projecting from the middle of the back; it measures, on an average, rather more than one-third inch, and varies in color from light green with darker green shadings, to pale straw-color with light brown shadings.

The philosophic student of insect life cannot fail to be struck with the wonderful disguises which these little animals often assume, the better to escape detection from their enemies. The instances of protective mimicry are more numerous among insects than among any other Class of animals, and in the last part of this Report, I shall have occasion to refer to this subject more fully. I had often wondered why the pupa of the Grape-vine Plume was seldom noticed in the open vineyard, and I very well recollect, when three years ago, this worm was abundant in the vineyard of the Rev. Charles Peabody of Glenwood, I. M. R. R., that he one day expressed great astonishment at their total and sudden disappearance. I told him that

* As Dr. Fitch's description of this larva is the only one I know of, and is rather incomplete, I subjoin the following for the scientific reader:

MATURE LARVA OF PTEROPHORUS PERISCELIDACTYLUS.—Average length 0.50 inch. Color pale greenish-yellow. Joints separated by deep constrictions. Each joint with a transverse row of large cream-colored warts, giving rise to soft white hairs, many of which are slightly clubbed at tip. Four of these warts above, and six below stigmata, the four lower smaller than the six upper ones. The hairs from warts above stigmata diverging in all directions and straight, those from the row immediately below stigmata decurving. Other short and more minute club-tipped hairs spring from the general surface of the body between the warts. Head yellow, with labrum slightly tawny. Legs also yellow, immaculate and very long and slender. Described from numerous living specimens.

they had changed to the pupa state and were more thoroughly hidden among the leaves; but he did not succeed in feeding any of the pupæ, and I did not then suspect that we have here a case of mimicry. From some interesting facts communicated to me by Mr. M. C. Read of Hudson, Ohio, I am satisfied, however, that we have here a clear case of protective disguise. He says: "Of a large number raised in jars by me, there were two well defined colors, one a reddish-brown resembling closely the bark of ripe grape wood, the other a light green, or exactly the color of the leaves and young wood. Without an exception the green ones were attached to the green leaves and green wood, or to the sides of the glass jar of very similar color; while all of the brown ones were attached to stems of the ripened grape-wood." Having noted this fact he put large numbers of larvæ in a jar with sticks and material of various colors, but he obtained only the two varieties of pupæ and each was invariably attached to an article of the same color as itself.

So far as I recollect the facts noticed in my own breeding of this insect, they accord with the observations of Mr. Read, and there is no reason to doubt that in a state of nature the green variety confines itself to the leaves, and the brown variety to the wood of the vine. Upon the theory of Natural Selection, *i. e.*, in this case, the preservation of the best disguised specimens, these facts become significant, and it is easy to understand how the two distinct forms would in time inevitably be produced; but whether these singular disguises be explained on that theory or on any other, they are equally interesting and afford good food for the reflective mind.

The moth (Fig. 27, *d*) escapes from this pupa in about one week, and, like all the species belonging to the genus, it has a very active and impetuous flight, and rests with the wings closed and stretched at right angles from the body, so as to recall the letter T. It is of a tawny yellow color, the front wings marked with white and dark brown as in the figure, the hind wings appearing like burnished copper, and the legs being alternately banded with white and tawny yellow.

All the moths of the family (ALUCITIDÆ) to which it belongs have the wings split up into narrow feather-like lobes, and for this reason they have very appropriately been called Plumes in popular language. In the genus *Pterophorus* the front wings are divided into two, and the hind wings into three lobes. As I have shown in my first Report we have a somewhat larger species (*P. carduidactylus*, Riley) which occurs on the Thistle, and which, though bearing a close resemblance to the Grape-vine Plume in color and markings, yet differs very remarkably in the larva and pupa states.

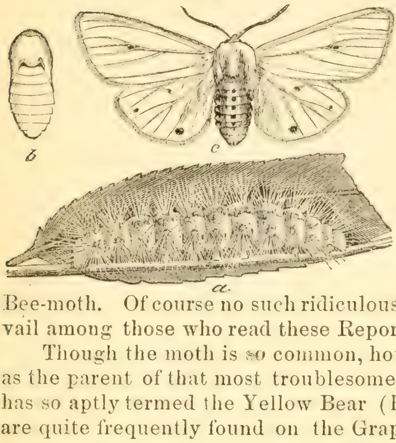
From analogy we may infer that there are two broods of these worms each year, and that the last brood passes the winter in the moth state. I have, however, never noticed any second appearance of them, and whether this is from the fact that the vines are covered with a denser foliage in the summer than in the spring, or whether there is really but one brood, are points in the history of our little Plume which yet have to be settled by further observation.

On account of its spinning habit, which enables us to detect it, this insect is easily kept in check by hand picking.

THE COMMON YELLOW BEAR—*Spilosoma virginica*, Fabr.

(Lepidoptera, Arctiidæ.)

[Fig. 28.]



This is one of the most common North American insects. The moth (Fig. 28, *c*) which is very generally dubbed "the Miller," frequently flies into our rooms at night; and there are quite a number of our farmers who, somehow or other, have got the idea that this "Miller" is the insect that infests their bee-hives—that it is, in short, the Bee-moth. Of course no such ridiculous idea could for a moment prevail among those who read these Reports.

Though the moth is so common, how few persons ever think of it as the parent of that most troublesome of caterpillars, which Harris has so aptly termed the Yellow Bear (Fig. 28, *a*). These caterpillars are quite frequently found on the Grape-vine, and when about one-fourth grown bear a considerable resemblance to the mature larva of the Grape-vine Plume which we have just described. They seldom appear, however, till that species has disappeared, and may always be distinguished from it by their semi-gregarious habit at this time of their life, and by living exposed on the leaf (generally the under side) instead of forming a retreat within which to hide themselves, as does the Plume.

The Yellow Bear is found of all sizes from June to October; and though quite fond of the vine, is by no means confined to that plant. It is, in fact, a very general feeder, being found on a great variety of herbaceous plants, both wild and cultivated, as butternut, lilac, beans, peas, convolvulus, corn, currant, gooseberry, cotton, sunflower, plantain, smart-weed, verbenas, geraniums, and almost any plant with soft, tender leaves. These caterpillars are indeed so indifferent as to their diet, that I have actually known one to subsist entirely, from the time it cast its last skin till it spun up, on dead bodies of the Camel Cricket (*Mantis carolina*).

When young they are invariably bluish-white, but when full-grown they may be found either of a pale cream-color, yellow, light brown or very dark brown, the different colors often appearing in the same brood of worms, as I have proved by experiment. Yellow is the most common color, and in all the varieties the venter is dark, and there is a characteristic longitudinal black line, more or less interrupted, along each side of the body, and a transverse line of the same color (sometimes faint) between each of the joints: the head and feet are ochre-yellow, and the hairs spring from dark yellow warts, of which there are 10 on each joint, those on joint 1 being scarcely distinguishable, and those on joint 12 coalescing. There are two broods of these worms each year, the broods intermixing, and the last passing the winter in the chrysalis state. The chrysalis (Fig. 28, *b*) is formed in a trivial cocoon, constructed almost entirely of the caterpillar's hairs, which, though held in position by a few very fine silken threads, are fastened together mainly by the interlocking of their minute barbs, and the manner in which the caterpillar interweaves them.

The moth makes its appearance as early as the first of May in the latitude of St. Louis, but may often be found much earlier in stove-warmed rooms. It is easily recognized by its pure white color, by its abdomen being orange above, with three rows of black spots, and by the black dots on its wings. These dots vary in number, there being usually two on each of the front and three on each of the hind wings, though sometimes they are all more or less obsolete, except that on the disk of the front wings.

It is fortunate for us that this caterpillar is attacked by a large number of insect parasites; for, were this not the case, it would soon multiply to such a degree as to be beyond our control. I know of no less than five distinct parasites which attack it—some living singly in the body of the caterpillar, and issuing from the chrysalis without spinning any cocoon of their own; others living singly in the body, but forming a cocoon of their own inside the chrysalis of their victim, and still others infesting the caterpillar in great numbers, and completely filling the chrysalis with their pupæ.*

The best time to destroy these worms is soon after they hatch from their little round yellow eggs, which are deposited in clusters; for, as already intimated, they then feed together.

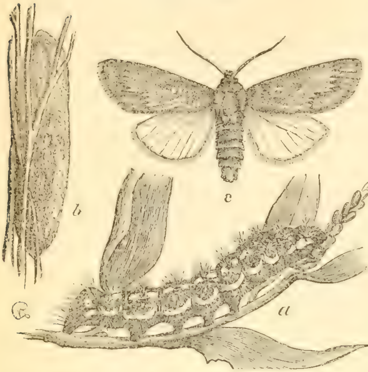
* For the benefit of the scientific reader I enumerate the five parasites which I have ascertained to infest this caterpillar: 1. *Anomalon flavicorne* (Brullé Hym IV, p. 171). 2. *Ichneumon subcyaneus*, Cress. (Proc. Ent. Soc., Phila., III, p. 148), and *Ich. pullatus*, Cress. (Pro. E. S. P., III, p. 146), described as a distinct species, but *pullatus* is evidently the male, and *subcyaneus* the female of the same species, as I have bred from *Spilosoma virginica* three males all answering to the description of the former, and two females both answering to the description of the latter. 3. *Ichneumon signatipes*, Cress. (Trans. Amer. Ent. Soc., I, p. 308). 4. *Ophion bilineatus*, Say. (Ent. of N. A., I, p. 379). 5. A small undetermined, and probably undescribed Dipteron belonging to the MUSCADÆ.

THE SMEARED DAGGER—*Acronycta oblinita*, Sm. & Abb.

(Lepidoptera, Acronyctidæ.)

This is another insect which is occasionally found upon the Grapevine, but never in sufficient numbers to do any considerable harm. It is one of our most common insects, and a very general feeder, occurring on a great variety of herbaceous plants, among others asparagus and cotton, and being especially partial to the common smart-weed (*Polygonum hydropiper*). It also feeds on some shrubs and trees, occasionaly proving quite injurious, for Mr. F. A. Nitchy, of Jefferson City, sent me specimens last summer with the statement that they were very numerous on his peach trees, and I have known it to denude both apple and willow trees.

[Fig. 29.]



The larva (Fig. 29, *a*) is easily recognized by the distinct wavy bright yellow band at the side, and the transverse row of crimson-red warts and stiff yellowish or rust-red bristles across each joint, in contrast with the black color of the body. When full grown it draws a few leaves or stems together, or retreats into some fence corner, and spins a narrow elongated cocoon (Fig. 29, *b*) generally white, but occasionally inclining to ochre-yellow, some which I have found on Willow being of this last color. The chrysalis is very dark brown, and, with the exception of a smooth shiny band on the posterior border of each abdominal joint, is rough or shagreened. It has the power of violently turning round and round in its cocoon when disturbed, thereby causing a rustling noise. The moth (Fig. 29, *c*) has the front wings of an ash-gray color, caused by innumerable dark atoms scattered over a white ground, and there is a distinct row of black dots along the posterior border, a more or less distinct black zigzag line across the outer fourth, and some dusky spots just above the middle of the wing. The hind wings are pure white.

There are two broods each year, the first brood of worms appearing for the most part during June, and giving out the moths in July, and the second brood occurring in the fall, passing the winter in the chrysalis state, and producing moths the following May.

Handpicking is the only remedy that it has been found necessary to adopt with this caterpillar whenever it becomes troublesome.

There are at least three natural enemies which serve to keep it in check. The largest of these is the Uni-banded Ichneumon-fly (*Ichneumon unifasciatorius*, Say), a large black fly, 0.60 inch long, and characterized by a white annulus about the middle of the antenna, a large white spot about the middle of the thorax, and a white band on the first joint of the abdomen.

This fly oviposits in the larva of the Smeared Dagger, but the latter never succumbs till after it has spun up and become a chrysalis, for I have always obtained the Ichneumon from the chrysalis. The other parasites are smaller and work differently. They each cause the larva of the Smeared Dagger to die when about full grown, and its contracted and hardened skin, which may often be seen during the winter, with the head attached (Fig. 30, *a*), fastened to the twigs of apple and wil-

[Fig. 30]

low trees, forms a snug little house where the parasite undergoes its transformations and through which it gnaws a round hole (Fig. 30, *b*), to escape the latter part of April. One of these flies (*Aleiodes Rileyi*, Cresson,) is described on page 382, of Volume II, of the Transactions of the American Entomological Society, and is of a uniform reddish-yellow color. The other is a black fly of about the same size, but belonging to an entirely different genus, *Polysphincta*. It has two prominent carinæ on the dorsum of the basal joint of the abdomen, and the legs, except the hind tarsi and last half of hind tibiæ are rufous. It is marked *bicarinata* in my MS., but I omit the description as I do not possess the female. The first of these parasites is in its turn preyed upon by a minute *Chalcis* fly of a steel-blue color with honey-yellow legs, which issues in great numbers through a very minute hole, from the dried caterpillar skins.

As I know of no description of *oblinita* in the English language, and as that of Guenèe is rather summary, I subjoin the following:

Acronycta oblinita, Sm. and Abb.—*Imago*—Front wings oblong; apex more or less prolonged; posterior margin sometimes rounded, sometimes straight; color ash-gray, caused by numerous dark brown atoms more or less suffused on a white ground, from which the ordinary lines are barely discernible in the better marked individuals; a row of distinct black dots along posterior border; the ordinary spots represented by blurred marks or entirely obsolete; the undulate line across posterior fourth of wing distinct, and relieved inside by a pale coincident shade, with the teeth quite aciculate and with the psi-spot so characteristic of the genus, but rarely traceable; fringe narrow and generally entire. Hind wings pure white, with a faint row of dark spots around posterior border. Under side of both wings white with faint fulvous tint and faint irrorations; each wing showing the brown discal spot and the row of points at posterior border. Head and thorax speckled gray; abdomen whitish-gray; antennæ short, simple in both sexes, gray above and brown below; palpi small. Two specimens with the front wings very dark, showing the ordinary lines and spots conspicuously, and with the antennæ brown above as well as below. Average length, 0.75; expanse, 1.75 inches.

Described from numerous bred specimens.

Larva—Prevailing color black. Each joint with a transverse dorsal crimson-red band across the middle from stigmata to stigmata, and containing six warts, each furnishing 10 or 12 or more stiff yellow or fulvous bristles, and the two dorsal ones being farthest apart. A sub-dorsal longitudinal yellow line interrupted by this transverse band and at incisures, in such a manner that the black dorsum appears somewhat diamond-shaped on each joint. A broad, wavy, bright-yellow stigmatal line, containing a yellow bristle-bearing wart in middle of each joint. Lateral space occupied with different sized pale yellow spots, largest towards dorsum. Head chesnut-brown. Venter crimson-black, with bristle-bearing warts of same color. Stigmata oblong-oval and pale. Thoracic legs black; prolegs with black extremities. Such is the normal appearance of this larva, but it is very variable. In some the yellow seems to predominate over the black, and there is a more or less distinct dorsal line. In some this dorsal line forms a mere speck at the incisures of the middle joints. The transverse crimson band is often entirely obsolete, and the warts distinctly separated, while in others where this band is distinct, the warts frequently coalesce.

Pupa—Almost black, and shagreened with the exception of a smooth and polished rim, at posterior border of joints, which becomes reddish, especially ventrally, on the three joints immediately below wing-sheaths. Terminal joint horizontally compressed, squarely cut off, and furnished with a little brush of short evenly-shorn, stiff rufous bristles.

THE PYRAMIDAL GRAPE-VINE WORM.—*Amphipyra pyramidoides*, Guen.

(Lepidoptera, Amphipyridæ.)

Another worm, never hitherto mentioned as injurious to the Grape-vine, is often found resting upon it in the posture shown in Figure 32, and may be at once distinguished from all others that are known to attack it, by having a pyramidal hump near the end of its body. This worm I have also found upon the Red Bud (*Cercis canadensis*), the Raspberry and the Poplar, but it is only as a vine-feeder that it can be considered injurious.

[Fig. 31.]

It was more abundant in the summer of 1869 than it has been since. According to the experience of Mr. G. Pauls, of Eureka, it takes the Hartford, Israella and Iona first, and the Concord and North Carolina next, and devours the blossoms as well as the leaves. It is of the form shown in the figure and of a delicate green color, marked with pale yellow or cream-colored lines and spots, as there indicated. It is found on the vines during the month of May with us, and during the forepart of June descends to the surface of the ground, where it spins a loose cocoon of whitish silk, generally constructed between some fallen leaves. Within this cocoon it remains some time in the larva state, but eventually becomes a shiny mahogony-brown chrysalis from which emerges a moth (Fig. 31), with the front wings bark brown and glossy and marked with dark brown and pale grayish-brown as in the cut; and with the hind wings of a lustrous copper color, from which character it may be called in popular language the American Copper Underwing. In Chicago, Illinois, this insect is single-

[Fig. 32.]

brooded, for a poplar-feeding larva found the latter part of May, and which spun up on the 14th of June, did not produce the moth till the following April; but specimens obtained near St. Louis often produce the moth during July of the same year that they are found as worms. In this last case a second brood is doubtless produced the same year though it is barely possible that the moths winter over and do not deposit till spring; for they are characterized by having very flat bodies, and with their wings folded flatly on their backs they are often found hiding in narrow cracks and crevices where they seem to love to shelter.

There is an insect (*Amphipyra pyramidea*, Linn.) very common throughout the continent of Europe, on Elm, Poplar, Oak, and other trees, and known in England as the Copper Underwing, which our *pyramidoides*, as its name implies, so very closely resembles in all its stages, that it is difficult for one who has become acquainted with both insects in the field, to bring himself to believe that they are really distinct species. No one can behold the two moths and speculate on their great similarity, without feeling that such close resemblance between the insects of two continents is hard to account for on any other theory than that of community of descent; or without questioning whether there really are differences enough to make two species, when he reflects that far greater variations often occur in the particular species of a given continent! The most constant difference seems to occur in the larvæ which, though they agree in almost every other detail, differ in the European species having the pyramidal hump more strongly developed and capped with a red horn-like point which curves backwards, while in our species this point is more or less obsolete and not red.

REMEDIES.—This worm is easily kept in check by hand-picking, and though its moth is attracted by sweets, it has never been numerous enough in the past to warrant this mode of capturing it. We have no good description of this insect in the English language, so I subjoin one.

AMPHIPYRA PYRAMIDOIDES, Guen.—*Larva*, (Fig. 32.)—Length when full grown 1.20–1.30 inch. Smallest at joint 1, largest at joint 11 which rises pyramidally above the others. Color pale bluish-green inclining to whitish dorsally, and rather darker at each end than in the middle of body. A continuous narrow cream-colored medio-dorsal line extending from the head to extremity of anal shield; a subdorsal line of the same color or somewhat more yellow, wavy and broken into 4 or 5 unequal spots on each of joints 1–10, more or less distinct, ascending continuously on joint 11 to the summit of pyramid, descending in a curve and vanishing in the anal shield; a broader stigmatal line, bright sulphur-yellow, except where intercepted by stigmata where it is white, distinct on joints 1 and 2, less so on 3 and 4, and running straight to the extremity of anal shield. Looking downwards from the top of the pyramid, six lines seem to radiate from it in as many different directions. Besides these lines, each joint has about ten cream-colored piliferous spots, namely, 4 in dorsal space—the anterior ones nearest together—one in the middle of each joint in subdorsal space, and 2 smaller substigmatal ones. These spots are more or less obsolete on the thoracic and anal joints; they are arranged transversely on the former, and the hairs arising from them are so insignificant that they are scarcely visible. Stigmata white, with a black annalation. Head free, smaller than joint 1, concolorous with body. Venter darker green with cream-colored points. Legs of the same color, the thoracic with three brown, or black spots outside, the prolegs with purplish clingers. Described from two grape-feeding, two poplar-feeding specimens.

Pupa.—Highly polished mahogony-brown, rather short and thick, impunctate, and with two small short spines and several fine curled bristles at the extremity.

Imago.—*Front Wings,* with the costal margin more or less arched and the posterior margin more or less scalloped or dentate; general color brown, being variegated with a pale glossy gray, with more or less fulvous, glossy purple-brown and unpolished purple-black; the transverse anterior nearly obsolete or tolerably well defined, in strong zigzag, pale with a dark shade each side; reniform spot entirely obsolete, or well indicated and pale; orbicular small and illy defined, or large and forming a pale ring with the centre sometimes concolorous, sometimes lighter than median space, and with the basal side sometimes, not always, extended into a beak or point; transverse posterior well relieved inside but not outside, except at costa; it starts distinctly about the middle or a little outside the middle of costa, runs outwardly at right angles along costal nerve, either its own width or twice its width, thence obliquely outwards towards the middle of the wing, with a more or less conspicuous inward jog or curve in discoidal cell; thence across the wing in 4 undulations: in some specimens it makes an obtuse angle, so that the inner half runs parallel with the posterior margin, in others it runs almost straight across the wing, so as not to be parallel with the margin at any point; in some it traverses the wing so as to leave a full third, in others so as to leave only a fourth of the wing outside; subterminal line pale and broken, scarcely distinguishable, or well defined, especially at costa, where the apical space is pale and blends with it, or as brown as the rest of wing and relieves it; a series of 8 more or less distinct pale terminal dots, often relieved by an outer black shade, fringes concolorous: sometimes with a pale middle line often broken and appearing like a second series of dots; the posterior median space is the darkest, and the subterminal space the lightest portion of the wing, though the contrast is often very slight. In one dark specimen the sagittate spots and a longitudinal shade in the discoidal cell and another below the sub-median nerve—the two dividing the wing in three equal parts longitudinally—are very conspicuous from their being very dark and without gloss; in two specimens these marks are entirely obsolete; under surface smoky-gray, more or less suffused with fulvous, and with a dark shade below transverse posterior. *Hind wings* bright glossy cupreous, or with but a very faint tint of this color, and more or less distinctly grayish-brown along the costa to the third superior nerve and the upper posterior border; fringe scalloped, grayish-brown, with an inner paler hue; under surface more or less concolorous, with the lunule indicated and with a broad line, half black, half cupreous. *Thorax,* with the scales large and mixed fulvous and brown. *Abdomen,* with the sides dark, intercepted by the fulvous margins of joints; anal tuft more or less rufous. *Legs* with the tibiæ and tarsi alternately fulvous and brown. Expanse 1.65–1.90 inches.

Described from four bred and four captured specimens.

The differences between the European *pyramidea* and this species, as given by Guenée, are: First, In *pyramidea* the transverse posterior curves outward near the costa, so as to produce an inward sinus in the discoidal cell, while in *pyramidoides* it runs nearly straight and obliquely; Secondly, in *pyramidoides* this line is said to border a median space almost always darker than the rest of wing and absorbing the darker longitudinal lines, while the light lines are given as narrower than in *pyramidea*, and the subterminal more continued to costa, where it borders, or cuts, as Guenée has it, a light apical space. While the difference mentioned in the transverse posterior is tolerably constant in the eight specimens of *pyramidoides* in my possession, I have seen two in other collections where this line was almost a fac-simile of the same line in *pyramidea*; and the other characters, as will be seen from the above description are quite variable, sometimes approaching the typical *pyramidea* and sometimes the typical *pyramidoides.* The same variations doubtless occur in the European species, for if we can rely on Mr. Edward Newman's figure (British Moths, p. 457,) the median space is sometimes as much darker than the subterminal in their insect as it is said, by Guenée, to be in ours Upon critically examining two European specimens of *pyramidea* in the collection of my friend, Mr. A. Bolter, of Chicago, I find this shade very distinct on the posterior portion of the median space, but instead of closely bordering and relieving the transverse posterior it fades somewhat before reaching it. The transverse posterior crosses the wing nearer the middle than in our species, leaving, in one of the specimens, more than one-third of the wing outside. But the distinguishing features which struck me as less subject to variation than those mentioned by Guenée, are the somewhat more elongate wings and the broader, more distinct, subterminal line of *pyramidea.* I have little doubt, however, but that from a hundred specimens of each species at least one *pyramidea* and one *pyramidoides* could be found that were undistinguishable in themselves. The undersides of the two species agree entirely.

There is but one other described, N. A. *Amphipyra,* namely, the *A. inornata* of Grote—(*Pro Ent. Soc, Phil.,* III, p. 86,) which upon the very face of it, seems to be but a small variety of *pyramidoides,* as will be seen by comparing his description with that found above. The species was described from a single specimen belonging to Mr. Wm. Saunders, of London, Ont., who agrees with me in believing it to be but a variety of *pyramidoides.*

I have a unique in my cabinet which differs so remarkably in the front wings from *pyramidoides* that I feel constrained to briefly describe it, and yet in all other characters it so closely resembles that species that I should hesitate to do so, had I not bred it from the larva. It looks exactly as though something had been sprinkled uniformily over the front wings and had eaten the dark color away in spots and splashes, but the specimen is in reality perfect, with not a scale ruffled. It may be called the Spattered Copper Underwing :—

AMPHIPYRA CONSPERSA, N. Sp.—*Larva.*—Found full grown July 2nd, 1867 on Hazel. No pyramindal hump, and of a uniform emerald-green, the dorsal palpitations visible and the stigmata pale with a black annulation, but with no other markings either on the head, body or legs.

Imago—Like *pyramidoides* in every particular except that the brown of front wings is almost uniformily spattered over, more or less suffusely with pale grayish spots so that no regular marks appear. The costal marks are however tolerably distinct as in *pyramidoides* and by careful examination and comparison, traces of the more conspicuous marks of that species may be discerned.

Described from one ♀ bred July 31st.

THE GRAPE-ROOT BORER.—*Ægeria polistiformis*, Harr.

(Lepidoptera, Ægeridæ.)

The most common root-borers of the Grape-vine in this State are those which I have termed Gigantic Root-borers, namely, the larvæ of two large beetles (*Prionus laticollis* and *P. imbricornis*) which were treated of in my previous Reports. The insect now under consideration is a moth and not a beetle and has for a number of years been known as THE Grape-root Borer. It bears a very close resem-

[Fig. 33.]

a *b*

blance to the common Peach Borer, both in habit, and in the size and general appearance of the larva, but it is a somewhat larger insect and the moths differ materially.

It has usually been considered a Southern insect and certain it is that it is not as destructive in the vineyards of Missouri as the Gigantic borers. But I captured specimens of the moth and found the larva in St. Louis county last summer, and it has long been known to be destructive throughout Kentucky. It was also reported around Cincinnati in 1867, though there is no evidence that the insects attacking vine roots there were this species and not the Gigantic borers.

The larva can easily be distinguished from the Gigantic root-borers, by having 16 legs as in all normal Lepidopterous larvæ, namely, six true horny legs head near the and ten false or membranous legs, eight of which are in the middle and two at the end of the body. When full grown it measures from an inch to an inch and three-quarters, and it then forms a pod-like cocoon of a gummy sort of silk covered with little bits of wood-bark and dirt, within or adjacent to the injured root. Within this cocoon it becomes a chrysalis which, in due time, by aid of rows of minute teeth with which it is furnished, works its way out of the cocoon to the surface of the ground, and gives forth the moth. As with the Peach Borer, this insect requires a year to develop and is found in its different states of larva, chrysalis and moth, throughout the summer months, and it doubtless also passes the winter as a larva.

The moth looks very much like a wasp and especially like some belonging to the genus *Polistes*—whence its specific name—and the resemblance becomes still more striking when flying, for its flight is accompanied by a buzzing wasp-like noise. The sexes differ considerably though not as much as in the case of the Peach Borer. The colors are dark brown and tawny-orange, and the male is well represented at Figure 33, *a*, and the female at *b*, but as the description which was published seventeen years ago by Harris, and copied by Mr. Walsh in his Report, is brief and defective, I subjoin one which is more complete:—

ÆGERIA POLISTIFORMIS, Harris,—*Imago* ♀—*Head*, including the palpi, orange-tawny. Antennæ simple, blue-black; orange-tawny above at their extreme base and tip and below for their entire length. *Thorax* black; varied with orange-tawny and bright yellow on the lateral and posterior surface above, and below for its entire surface. *Abdomen* generally with the four basal joints black and the rest orange-tawny; sometimes almost entirely orange-tawny; sometimes almost entirely black; always with a narrow yellow ring at the tip of the second joint above and generally with another such ring at the tip of the fourth joint; venter mostly black with the tip of all the joints more or less edged with orange-tawny, and with a short lateral pencil of orange-tawny hairs springing from the tip of the penultimate joint below, and reaching a little beyond anus. Legs orange-tawny above, mostly black below but with a yellow patch at the origin of the middle spurs on the hind tibiæ. All the spurs and tarsi more or less tinged with yellow. Front wings brown-black with a more or less distinct clear space at base, longitudinally traversed by a nervure; hind wings hyaline, with the veins, the terminal edge and the fringe, brown-black. Length 0.66—0.85 inch; expanse 1.15—1.50.

The ♂ differs from the ♀ as follows:—1st. The antennæ are bipectinate four-fifths of the way to the tip, which is strongly clavate and, as in the ♀, bears a few hairs at its apex. The bipectinations are fully one-fourth as long as the head is wide, and, as well as the entire basal half of the antennæ are orange-tawny. 2nd. Both thorax and abdomen are darker, and in addition to the pair of short anal pencils below, there is a pair nearly twice as long above. 3rd. The short hyaline space straddling a black nervure at base is more distinct. Length 0.68 inch; expanse 1.10 inch.

Described from 1 ♂ 1 ♀ bred July 8th—16th, from grape roots, and others captured during August at Kirkwood, Mo. It is remarkable that although Dr. Harris chronicles in his correspondence with Dr. LeBaron, as a notable event, his having captured an *Ægeria* with pectinate antennæ in New England in 1850,* in 1854, when for the first time he described the moth of our Grape-

*Harris correspondence, p. 262.

root borer, he did not say a single word about the ♂ antennæ being bipectinate, if we are to judge from the account he gives in a Report made to the American Pomological Society in 1854 (p 10.) Either his ♂ specimens had lost their antennæ, or the pectinations were rubbed off, the former being the more likely occurrence. Certain it is that the males received by Dr. Harris once had pectinated antennæ, for though Mr. Glover, copying after Harris, likewise fails to mention this sexual character in his account published in the Patent Office Report for 1854 (p. 80), he nevertheless plainly figures the pectinations (Ibid, Pl. 6, lower right hand figure) and the specimens from which he made the figure were received from the very same person who furnished Dr. Harris with his specimens.

Unlike the Peach Borer which makes its abode quite near the surface, this borer lives exclusively under ground, and unlike the Gigantic root-borers which hollow out and bore up along the heart of the roots, it confines itself almost entirely to bark and sap-wood, and the effects of its work are consequently more fatal to the vine. Roots attacked by it, to use one of Mr. Walsh's expressions, look "as if a drunken carpenter had been diligently scooping away the sap-wood with a quarter-inch gouge." It must, however, sometimes hide under the bark of the roots, as Mr. H. J. Kron of Albemarle, North Carolina, in the Monthly Report of the Department of Agriculture for 1867, (p. 329), describes it as being shielded by the bark.

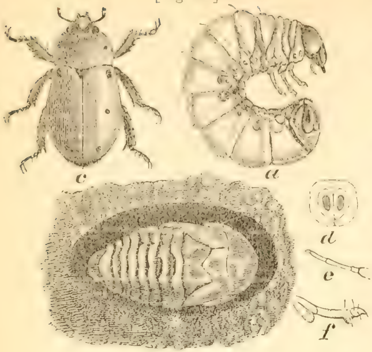
REMEDIES—It has been ascertained by observation and experiment that the Scuppernong grape-vine—which, according to Gray, is a cultivated variety of the Southern Fox Grape (*vitis vulpina*)—is never attacked by this borer, and consequently that other varieties grafted on to the Scuppernong share its immunity from attack. This is a very easy mode of preventing its ravages in the more Southern States where the Scuppernong flourishes; and if this borer should ever become very numerous with us, it may be deemed advisable to introduce that stock here. At present we have no other preventive than mounding, and the insect is so comparatively scarce that I have not yet had an opportunity of testing whether such mounding would work as well as it does with the Peach Borer. When it is once ascertained that the borers are at work on a vine, they may be destroyed by clearing away the earth and applying hot water to the roots.

THE SPOTTED PELIDNOTA—*Pelidnota punctata*, Linn.

(Coleoptera, Scarabæidæ.)

This is the largest and most conspicuous beetle that attacks the foliage of the Grape-vine, and in the beetle state it seems to subsist entirely on the leaves of this plant, and of the closely allied Virginia Creeper. Though some years it becomes so abundant as to badly riddle the foliage of our vineyards, yet such instan-

[Fig. 34.]



ces are exceptional; and it usually occurs in such small numbers, and is so large and clumsy, that it can not be considered a very redoubtable enemy.

Its larva has, for a number of years been known to feed on the decaying roots of different trees, but was first described by me last September.* It is a large clumsy grub (Fig. 34, *a*) bearing a close resemblance to the common White Grub of our meadows, and it differs from that species principally in being less wrinkled, and in having the chitinous covering (or skin, so-called) more polished and of a pure white color, and in the distinct heart-shaped swelling above the anus (Fig. 34, *d*). Towards the latter part of June I have found this larva in abundance, in company with the pupa (Fig. 34, *b*), in rotten stumps and roots of the Pear. In preparing for the pupa state, the larva forms a rather unsubstantial cocoon of its own excrement, mixed with the surrounding wood. The pupa state lasts but from eight to ten days, and the beetle (Fig. 34, *c*) is found on our vines during the months of July, August and September. It is not yet known how long a time is required for the development of the larva, but from analogy we may infer that the insect lives in that state upwards of three years.

This beetle was named about a century ago by Linnæus who met with a specimen in the magnificent collection of shells and insects belonging to Queen Louise Ulrica of Sweden. It occurs throughout the States and Upper Canada, and is even met with in the West Indies. It flies and feeds by day, and is most abundant during the months of July and August. The wing-covers are of a slightly metallic clay-yellow color, with three distinct black spots on each, and the wings themselves are dark-brown inclining to black: the thorax is usually a little darker than the wing-covers, with one spot each side: the abdomen beneath, and legs, are of a bronzed-green. It is easily kept in check by hand-picking.

PELIDNOTA PUNCTATA, Linn.—*Larva* (Fig. 34, *a*)—Length 2 inches; clumsy, moving on the side. *Head*, bright chestnut-brown, smooth, rounded, with a short, impressed, longitudinal line on the top, and three shallow impressions in front; epistoma trapezoidal and darker; labrum rough, irregularly punctate, and beset on the margin with a few stiff rufous hairs; antennæ (Fig. 34, *e*) as long as epistoma and labrum together, 4-jointed exclusive of bulbus or tubercle in which they are inserted; joints cylindrical, proportioned in length as 2, 6, 4, 1, the terminal joint being often a mere bud; mandibles strong and black, with three denticulations at tip, and a very slight tooth at inner basal portion; maxillæ brown and subcylindrical on outside, angulated on inside, bearing two lobes, each terminating in an inwardly-curved corneous tooth, and each furnished

* See American Entomologist and Botanist, Vol. I, p. 295.

on their inner narrow edge with stiff bristles, the outside one arising close by base of palpus, the inside one extending lower down, and recalling by its form, the terminal joint of the front leg of a scorpion; maxillary palpi 4-jointed, joints cylindrical, short, very gradually longer and longer from 1 to 4, the terminal joint more pointed and narrower than the others; labium quadrangular, labial palpi 2-jointed, the palpigerous piece strongly beset with bristles. *Body*, smooth with but a few wrinkles at thorax; polished translucent white, with faint bluish marblings on all but thoracic joints which are slightly narrower than the rest; a narrow vascular dorsal line, and a very slight yellowish horny plate in a depression on joint 1; a very slight pubescence observable, and a transverse tergal row of sparse but tolerably long hairs on posterior part of each joint; more dense and conspicuous hairs on lower sides of anal joint, which joint is short, cut off squarely, with a heart-shaped swelling [Fig. 34, *d*) sunk into a circular depression, each lobe of the heart with a darker oval corneous elevation; spiracles sub-elliptical, dark chestnut-brown, placed on a prominent swelling, the lateral openings *all* facing the head, the 1st on joint 1, the rest on joints 4, 5, 6, 7, 8, 9, 10 and 11, gradually becoming smaller and smaller from first to last. *Legs* (Fig. 34, *f*) horny, light-brown and covered sparsely with hairs; coxæ long and stout, with a rounded swelling at lower anterior edge; femora cylindrical, sometimes, distinctly, at others indistinctly, separated from tibiæ, sometimes prolonged into a thorn below, with a distinct carina along the inside, at others not; tibiæ cylindrical, incrassated anteriorly, especially below; tarsi cylindrical and terminating in a distinct claw.

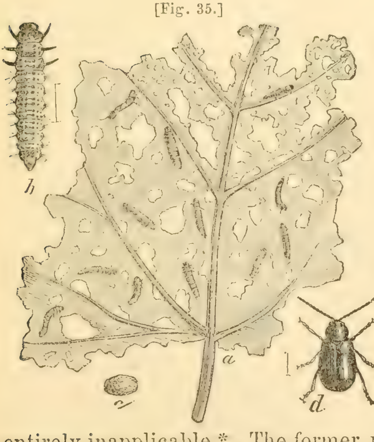
Pupa (Fig. 34, *b*) of the form of *Lachnosterna*.

Described from 12 living specimens.

THE GRAPE VINE FLEA-BEETLE—*Haltica chalybea*, Illiger.

(Coleoptera, Chrysomelidæ.)

[Fig. 35.]



Is there a grape-grower in the State of Missouri who does not know, to his sorrow, what the Grape-vine Flea-beetle is? Hardly one! And yet how few ever connect it with its disgusting little shiny brown larvæ, which generally prove still more injurious than the beetle, by riddling the leaves in the middle of the summer.

The Grape-vine Flea-beetle (Fig. 35, *d*) often goes by the cognomon of "Steel-blue Beetle," and is even dubbed "Thrips" by some vineyardists. The latter term, however, is entirely inapplicable.* The former name is not sufficiently charac-

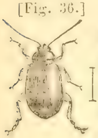
* The term *Thrips* is confined to an anomalous group of insects—mostly cannibal, but exceptionally vegetable feeding—of which Halliday made a separate Order (*Thysanoptera*), but which are to-day included in the *Homoptera*, or Whole-winged Bugs, by most authors, though they seem to have close affinities to the *Orthoptera*, and to the *Pseudoneuroptera*.

teristic, because the color varies from steel-blue to metallic-green and purple, and because there are many other flea beetles to which it would equally apply.

The Grape-vine Flea-beetle is found in all parts of the United States and in the Canadas, and it habitually feeds on the Alder (*Alnus serrulata*), as well as upon the wild and cultivated Grape-vine. Its depredations seem first to have been noticed in 1831, by Judge Darling, of Connecticut, and in 1834 Mr. David Thomas, of New York, published an account of it in the 26th volume of Silliman's *American Journal of Science*. Its transformations were, however, unknown till some time after Dr. Harris wrote his excellent work on Injurious Insects, and the figure of the larva was first published by myself last fall.

The beetles hibernate in a torpid state under any shelter which is afforded them in the vineyard, such as the loose bark and crevices of stakes, etc., etc., and they are roused to activity quite early in the spring. The greatest damage is done by them at this early season, for they often bore into and scoop out the unopened buds, and thus blight the grape-grower's bright expectations. As the leaves expand, the little jumping rascals feed on the leaves, and soon pair and deposit their small orange eggs in clusters, very much as in the case of the Colorado Potato-beetle. These eggs soon hatch into dark-colored larvæ, which may be found of all sizes during the latter part of May and early part of June. They are generally found on the upper surface of the leaf, which they so riddle and devour as to give it the appearance represented at Figure 35, *a*. When very numerous they devour all but the very largest leaf-ribs, and I have seen the wild vines throughout whole strips of country rendered most unsightly by the utter denudation which these insects had wrought. The larvæ feed for nearly a month, and when full grown present the appearance of Figure 35, *b*, the hair line at the side showing the natural size. They then descend from the vine and bury themselves a short distance in the earth, where, after each forming a little earthen cell (Fig. 35, *c*), they change to pupæ of a deep dull yellow color, and in about three weeks more issue as beetles. These beetles leave the ground from the middle of June to the middle of July, and, so far as I am aware, do not breed again till the following spring—there being but one brood each year. They subsist on the leaves during the fall, but the damage they inflict is trifling compared to that which they cause in spring.

[Fig. 36.]



Like all other Flea-beetles, this species has very stout, swollen hind thighs, which, though hidden in Figure 35, *d*, are well represented in the accompanying cut (Fig. 36). By means of these strong thighs they are enabled to jump about very energetically, and are consequently very difficult to manage during the summer months. In the winter time, however, they can be destroyed in great numbers while hidden in a torpid state in their retreats, for Dr. E. S. Hull, of Alton, Illinois, tells us* that they were once so numerous in a small vineyard of his that in the spring of 1867 he burnt them out by surrounding them with fire, and letting the fire run through the dry grass in the vineyard. "It was a rough remedy, but as his crop was destroyed, he let the beetles follow suit." Clean culture and general cleanliness in a vineyard will, to a great extent, prevent this insect's increase. Especially should the stakes be clean and free from old bark.

The larvæ can be more easily destroyed by an application of dry lime, used with a common sand-blower or bellows. This has been found to be more effectual than either lye or soap-suds, and is withal the safest, as lye, if used too strong, will injure the leaves.

This insect, like so many others, will one year swarm prodigiously, and then again be scarcely noticed; and such changes in its numbers depend mainly on conditions of the weather, as no parasite is known to attack it. In the spring of 1868, though they were at first out in full force, yet after some subsequent severe and cold weather, they had mostly disappeared. They are apt to be most troublesome where Alder abounds in the woods.

HALTICA CHALYBEA, Illig.—*Full-grown Larva.*—Length, 0.35 inch. Head polished black. Body livid-brown above, paler beneath; subcylindrical, the joints bulging, especially at sides, and each divided superiorly into two transverse folds; on each fold a row of six shiny-black elevated spots, the dorsal ones larger than the others, and often (especially the posterior two) confluent, or divided only by a very narrow dorsal line; each spot giving rise to a single short stiff hair; one such substigmatal black spot placed in middle of joint, and more elongated than the rest, being apparently composed of two confluent ones, as it gives rise to two hairs. Three ventral spots, one anteriorly, which is large, transversely-elongate, central, and without hairs; and two posteriorly (one each side) which are small and piliferous. Six black thoracic legs, and one anal orange proleg.

Pupa.—Length, 0.14 inch. Of the normal Chrysomelid form. Deep dull yellow, and covered more or less above with short black bristles arranged in a transverse row across each joint, and each arising from a slight elevation: two stouter anal bristles or thorns. Eyes brown. Tips of jaws brown.

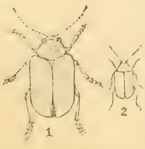
Described from numerous living specimens.

THE GRAPE-VINE COLASPIS—*Colaspis flavida*, Say.

(Coleoptera, Chrysomelidæ.)

There is a little clay-yellow beetle (Fig. 37, magnified, natural size), which does great injury to the Grape-vine by riddling the leaves. It is more or less abundant with us every year, but judging from recorded accounts is still more injurious in the Eastern States, and especially in New York. In the *Country Gentleman* for August 30th, 1866, occurs the following account of it by Dr. Fitch, in answer to a correspondent who wrote that they were destroying grape-vines by the wholesale:

[Fig. 37.]



* Proc. Alton Hort. Soc. for May, 1867.

"The rascals alluded to are a beetle of the Chrysomela family, and are the Brown Colaspis,* *Colaspis brunnea*, Fab. It is an oval, drab-colored beetle, nearly twice as long as broad, and nearly two-tenths of an inch in length, having the outer edge of his wing covers black, and also the under side of its body and the tip of its antennæ. It is rather a common insect throughout the United States, appearing in the latter part of June, each year, and continuing through the month of July. I have frequently gathered it from the wild grape-vine, the Cinquefoil or Potentilla, and some other plants, but have never known it to invade the cultivated grape until this year.

It has this season been the worst enemy that has attacked the vine in my neighborhood—riddling the leaves with small round holes, interspersed with large irregular ones—and I hear of it in several other parts of the country. * * *

Wherever the Leaf-folder (Fig.24) abounds, this beetle will almost invariably be found in conjunction with it in the fold of the leaf. On finding it so invariably in this fold, I at first supposed that it merely took advantage of the position for shelter, little suspecting that it would feed upon the worm, since the family to which it belongs is essentially herbivorous, and the Leaf folder is so very active; but from having found numbers of the shrunken and half-dead worms, I was led to conjecture that it does actually prey upon them; just as many true bugs (*Hemiptera*) though living naturally on the juices of plants, will still appropriate and relish those of certain caterpillars. Thus may one great pest serve to check another!

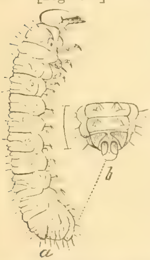
Of the natural history of this beetle nothing has hitherto been known. As the beetle was often found upon and greedily devours the leaves of the Strawberry, and as a white worm was known to injure the roots of that plant, I inferred several years ago (Prairie Farmer Annual 1868, p. 56), that this worm was the larva of the Colaspis. From the facts, however, that the larva of the European *Colaspis barbara* was described as a hexapod, blackish, glabrous grub

* Dr. Fitch referred this insect to *brunnea*, Fabr., and Mr. Walsh (*Practical Entomologist*, II, p. 68) criticised his course, and referred the species to *flavida*, Say. I adopt Say's name simply because it best indicates the general appearance of the insect, and not because I think Mr. Walsh was right in his strictures. I have kindly been allowed to examine Dr. Fitch's specimens; have examined specimens in other large Eastern collections, and those in the Walsh collection, and am convinced that the difficulty between the above two authors arises from the confounding of varieties with species. It is here, as in almost every other genus and Family, the closet systematist divides up and arranges with insufficient knowledge of the variation which species are subject to, and this was especially the case in years gone by, when every little colorational difference was generally supposed to be immutable. The naturalist, therefore, who studies insects for other and more laudable purposes than the mere naming and classifying of them, though fully aware of the importance and necessity of good and clear nomenclature, may well despair of bringing order out of the confusion which often exists, and which the miserably short and incomplete descriptions of older authors have had much to do in causing. The economist can spend his time more profitably, and so long as he always adds the authority to the name he uses, there will be no danger of causing more confusion, and he can coolly disregard the interminable disputes between different authors as to the proper technical name by which an insect should be known. In the present case, I simply give it as my opinion that *brunnea*, Fabr., *suilla*, Fabr., and *flavida*, Say, are all varieties of one species, because specimens according with each are found in the same vineyard, and because Say himself gives a variation in *flavida*, which differs much more from his description than does either *brunnea* or *suilla*. Mr. Walsh gives the antenna of *flavida* as having the last joint or two, and the tip of the last joint but four, brown-black, but there is variation here, and the dark color on the last joint but four is often obsolete. The exterior edges of the elytra are either concolorous or of all shades of brown to black, and the same may be said of the sutural edges. There is also a somewhat larger form, which must certainly be referred to the same species, which has the punctures so much less profound as to give it a much smoother and more highly polished appearance.

living unprotected upon the leaves of lucern and clover,* and that such was the character of the larvæ of most other insects belonging to the great *Chrysomela* family, I had little confidence that my reference would prove the correct one. Yet it so proved to be, and I have bred the beetle from larvæ infesting strawberry roots that were kindly sent to me by Mr. J. B. Miller, of Anna, Ills. Just as in the European Turnip Flea-beetle (*Phyllotreta nemorum*), the larva mines the leaves above ground, while in our very closely allied Striped Flea-beetle (*Phyllotreta striolata*, Illig.), it feeds upon the roots below ground; so there seems to be the same difference of habit in the genus *Colaspis*. In this last case the difference is not only of habit, but the structure is modified in accordance with the habit, and we have in our Grave-vine Colaspis a Chrysomelid larva bearing a very close resemblance to that of a Lamellicorn.

It is indeed a most singular larva, and differs from all others with which I am acquainted, in having on the underside of the legless joints a pair of curious fleshy projections reminding one of legs, and terminating in about two stiff hairs (Fig. 38, *a*). The office of these appendages it is difficult to conjecture, for they seem to impede rather than aid in locomotion on a flat surface, though, when the habits of the larva are more critically studied, these appendages will doubtless be found to subserve some useful purpose. The color of this larva is yellowish or grayish-white with a gamboge-yellow head. The pupa is formed in the ground and exhibits no unusual characters.

[Fig. 38.]



We are now only treating of this insect as a Grape-vine pest; but it is difficult to say whether the Crown-borer (Fig. 14) or this root-eater is the most injurious to the Strawberry. The work of the two is essentially different, the white Crown-borer confining itself to the crown, and its more dingy ally devouring the fibrous roots and working into the more woody parts from the outside. At this work several of them may frequently be seen with their heads stuck into different parts of one root. They may be found upon the roots all through the fall, winter and spring months, and do not begin to change to pupæ in this latitude till about the month of June, the beetles appearing during that month and continuing to issue from the ground till towards fall. As soon as they issue from the ground they commence to feed upon the tender leaves, and in a measure injure the plants by riddling them with holes. After feeding for a while on strawberry leaves, and depositing their eggs, they spread on to other plants and are generally found most numerous in the vineyard during the latter part of July and during August, where, according to Mr. Miller, they show a partiality for the leaves of the Delaware.

*Notice sur les Devastations de la Larve du *Colaspis barbara,* par M. Leon Dufour—Annales de la Soc. Ent. de France, 1836, pp. 371—372.

Such, in brief, is the history of this common beetle, as far as I have been able to trace it. It doubtless has natural enemies, and ants are so fond of the helpless pupæ that the Colaspis never occurs on the roots where they abound. The evil effects of its work are more apparent on young and newly set plants than on older ones, and the only way to prevent the ravages of the worm, which we yet know of, is to so protect newly set plants that the beetles will not get access to them. I have had no opportunity to make experiments, but it may turn out that some application to the ground or to the plant, such as ashes, soot, lime, or salt, will ward off the perfect beetle, and I shall be glad to hear reports from those who are troubled with the pest. The same remedies used in killing the Colorado Potato-beetle would also kill this species.

COLASPIS FLAVIDA, Say—*Larva*, (Fig. 38)—Color dingy yellowish; uniformly covered with sparse stiff yellowish hairs. Having the general appearance of a Lamellicorn larva. Slightly arched but capable of stretching out tolerably straight. Narrowest in middle of body, the thoracic and anal joints being slightly swollen. The joints with about three dorsal wrinkles to each. Head honey-yellow, rounded, flattened in front; epistoma and labrum of same color; jaws darker. Legs pale, setous, and terminating in a brown claw. Spiracles scarcely perceptible, the first sub-ventral between joints 1 and 2, the others placed on a lateral series of swellings commencing with joint 4. Joints 4-11 inclusive, each with a pair of soft ventral leg-like appendages, ending in two or more stiff hairs. Anal joint somewhat horny below (Fig. 38, *b*) but with no trace of prolegs. Length 0.25—0.30 inch. Described from two rather poor alcoholic specimens.

THE GRAPE-LEAF GALL-LOUSE—*Phylloxera vitifoliæ*, Fitch.

(Homoptera, Aphidæ.)

Here we have an insect, the life-history of which is as interesting to the entomologist as its devastations are alarming to the grape-grower. I have given it considerable attention the past summer, and though it is a difficult task to present definite and satisfactory information from the multitude of facts obtained, yet I shall endeavor to give a comprehensive account of this little louse, so far as my present knowledge of it will permit. In doing so I am made painfully aware that there is much room left for further observations, and he who will patiently and persistently devote his time for a few years to its study, and will with candor and accuracy give to the world the re-

[Fig. 39.]

sults, will doubtless be rewarded by new and important discoveries, and will render valuable service to the cause of science and of economic entomology.

The first reference to this insect was briefly made by Dr. Fitch, of New York, in the year 1856,** and he subsequently described it in a very insufficient manner, under the name of *Pemphigus vitifoliæ*;* but though the specific name must be retained, the insect was wrongly referred to the genus *Pemphigus*, as we shall presently see. Ten years afterwards this louse was again referred to by myself in the *Prairie Farmer* for August 3, 1866, and during the fall of the same year articles were written upon it by Dr. Shimer,† and by my late associate, Mr. Walsh‡—the former claiming that it was a true Plant-louse (*Aphis* family), and the latter that it was a Bark-louse (*Coccus* family). In this Dr. Shimer was evidently right, and Mr. Walsh wrong. In January, 1867, Dr. Shimer proposed for this insect a new family (DACTYLOSPHÆRIDÆ),§ which, in my opinion, cannot stand.

But not to weary the general reader with purely scientific questions, I shall give the reasons for my opinion on this point, together with some other details, in smaller type at the close.

This louse was subsequently treated of by Mr. Walsh in his report as Acting State Entomologist of Illinois (pp. 21-24), where he still felt inclined to place it with the Bark-lice, though I have good reason to believe that he afterwards changed his mind. During all this time a serious disease of the roots of the Grape-vine began to attract attention in the south of France, and it finally caused such alarm that the Minister of Agriculture and Commerce in France offered a prize of 20,000 francs for the discovery of an efficacious and practical remedy.

A special commission was also appointed to draw up a programme of conditions, examine memoirs submitted to it, settle the experiments to be made, collect evidence from local commissions, and if they saw reason for so doing, to award the prize offered by government. The commission consisted of M. Dumas, M. Milne Edwards and M. Duchartre, of the Paris Academy of Sciences; M. Gervais, M. Planchon, M. Henri Mares and M. Louis Vialla, of Montpellier; the Comte de Vergue, of Gironde; M. Bedel, of Vaucluse, and three members of the Ministry of Agriculture.

The disease is known as *pourridie*, or rotting. It is in the form of little cankerous spots, which cut off the supply of nourishment and cause the roots to rot, and these spots were ascertained by MM. Planchon and Lichtenstein, of Montpellier, to be caused by a louse (*Phylloxera vastatrix*, Planchon,) which bears a close resem-

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** N. Y. Rep. I, p. 158.

* Rep. 3, § 117.

† *Prairie Farmer*, Nov. 3 and Dec. 8, 1866.

‡ *Pract. Ent.*, Vol. I, p. 111; Vol. II, p. 19; and Proc. Ent. Soc., Phil., VI, pp. 283–4, notes.

§ Proc. Acad. Nat. Sci., Phil., Jan. 1867.

blance to our gall-insect. This is not all, for a leaf-gall absolutely identical with ours also occurs there, and the identity of the gall-inhabiting with the root-inhabiting insect was demonstrated by "J. O. W.," in the *Gardener's Chronicle*, of England, for January 30, 1869, and M. J. Lichtenstein even contended that their European species was identical with ours, and imported from this country, in which opinion he was supported by A. Combe-Dalmas.*

Of course these views expressed in Europe gave increased interest to our own gall-louse, and I determined to make every effort to decide the question of identity, together with some other questions which presented themselves. To this end I opened correspondence with M. V. Signoret and M. J. Lichtenstein, who were making experiments in France while I was doing the same here. But the blighting effects of the war have not only entailed untold misery and woe to millions in France, but have either paralyzed or effectually balked scientific investigation within her borders, so that at last accounts M. Lichtenstein was in Spain, and M. Signoret shut up in Paris.† I was, however, fortunate enough to receive from the latter gentleman, a few days previous to the investment of Paris, a letter stating that upon examination of specimens of our gall-lice, which I had expressed to him, he was convinced of their identity with the European species. This was indeed satisfactory, and coupled with the fact that I have discovered that our gall-insect likewise attacks the roots of our vines in precisely the same manner as does the European species, and that the winged specimens found in this country by Dr. Shimer agree in having the characteristic dusky band around the middle of the thorax described in the winged female of Europe, it leaves no doubt in my mind that the insects of the two continents are really identical.

As already stated, the war put a stop to investigations in France, and we do not know that any effectual remedy was discovered, or that the premium was disposed of. Carbolic acid, and two other substances, namely, sulphuret of lime dissolved in water, and an empyreumatical oil, known among veterinary surgeons by the name of "oil of cade," dissolved in water, were found to be the best specifics; but neither of them have been tried on a sufficiently extensive scale, and I have little faith in any medicinal remedy.

The two parties who have written most upon the disease, namely, Mr. Signoret and M. Lichtenstein, took entirely opposite grounds as to its cause. The former claimed that it had a botanical rather than an entomological cause, that it was principally due to drouth, bad culture and poor soil, and that the *Phylloxera* was therefore incidental; and acting upon this view, suggested that water, with manure

* *Insectologie Agricole*, 1869, p. 189.

† Since the above was written, I have heard from M. Signoret through M. Lichtenstein. Nothing daunted by the siege, the former carried on his studies of this little louse, and wrote by balloon, that though he himself was reduced to cats, dogs and horse-flesh, the *Phylloxera*, which he had in boxes, kept well and in good health. No doubt our enthusiastic friend finds much solace in thus pursuing knowledge under difficulties.

and good cultivation, would do away with it; while the latter maintained that the *Phylloxera* was the sole cause of the trouble. There are, doubtless, certain conditions of soil which will prove favorable to the increase of the louse, and it may also be influenced by the seasons and by good or poor cultivation; but that this insect should be found only on such roots as are already diseased is highly improbable, and there can be no reasonable doubt that M. Lichtenstein is right in attributing the disease directly to the *Phylloxera*. The appearance of mites is the almost inevitable consequence of diseased and rotting vegetation, but Plant-lice cannot live on such vegetation, and invariably leave it as soon as they have, by their punctures, reduced the healthy tissues to such a state. Moreover, the history of our louse, which I shall now proceed to give, corroborates M. Lichtenstein's views.

In Missouri this insect has proved very injurious to the Clinton vine for several years past—at least as far back as 1864, when the foliage of the Clinton was reported, in the proceedings of our State Horticultural Society, as "very bad"—and Mr. Geo. Husmann informed me that in 1869, it actually defoliated three-fourths of an acre of Clintons and Taylors on bottom land at Bluffton, though it did not appear to do much injury on the hills. It was quite bad around Kirkwood the present year, and, judging from reports, of correspondents and from my own observations, it was more than usually abundant in most of the Eastern States.

In this latitude the first galls are noticed by about the middle of May, and by the middle of June they begin to be quite common. It occurs most abundantly on the Clinton and Taylor, but is also found on the wild Frost Grape (*V. cordifolia*), and such other cultivated varieties of it as Golden Clinton and Huntington; also on the Delaware, and early in the year I even found a few large galls on the Concord. According to Dr. Morse it also occurs on the Iona, which is a variety of the Northern Fox Grape (*V. labrusca*). The galls vary somewhat in appearance, according to the vine upon which they occur, those I have noticed on the wild Frost Grape being more hirsute than those on the cultivated Clinton, and these again rougher than on the Taylor.

The few individuals which start the race early in the year station themselves upon the upper side of the leaves, and by constant suction and irritation soon cause the leaf to swell irregularly on the opposite side, while the upper part of the leaf gradually becomes fuzzy and closes, so that the louse at last sinks from view, and is snugly settled in her gall. Here she commences depositing, her bulk increasing during pregnancy. Eventually she grows to be very plump and swollen, acquires a deep yellow or orange tint, and crowds the space within the gall with her small yellow eggs, numbering from fifty to four or five hundred, according to the size of the gall. The young lice are pale yellow, and appear as at Figure 40, *d*, *e*. As soon as they are hatched they escape from the gall through the orifice on the upper surface of the leaf, which was never entirely closed; and, taking up their abode on the young and tender leaves, in their turn form galls. The mother-louse, after completing her deposit, dies, and the gall which she occupied dries up. There are several generations during the year, and this process goes on as long as the vines put forth fresh leaves. As the galls multiply and the growth of the vine becomes less vigorous, the young lice sometimes so completely cover the upper surface of the newly expanded leaves as not to leave room for them all to form galls. In this event the leaf soon perishes, and the lice perish with it. When two or more lice are stationed closely together they often form but one gall, which accounts for the presence of the several females that are sometimes observed in a single gall. Those leaves which have been badly attacked turn brown or black, and sooner or later fall to the ground, so that the vine may become entirely denuded.

By August the insects generally become so prodigiously multiplied that they often settle on the tendrils, leaf-stalks, and tender branches, where they form excrescences and gall-like growths, differing only from those on the leaves in such manner as one would naturally expect from the difference in the plant tissues. By this time the many natural enemies of the lice begin to play sad havoc with them; and after the vine has finished its growth, the young lice, finding no more succulent and suitable leaves, begin to wander and to seek the roots, so that by the end of September the galls are deserted, and those few remaining on the vines generally become mildewy, and finally turn brown and dry up. Upon the roots the lice attach themselves singly, or in little groups, and cause by their punctures little swellings and knots, which eventually become rotten. Where vines have been badly affected with the gall, it is difficult to find a perfectly healthy fibrous root. Strange enough, these lice not only change their residence as winter approaches, from the leaf above ground to the root below ground, just like the Moor, who, having passed the summer on his roof, gets into his house in the winter; but, Proteus-like, they change their appearance in shedding their skins, and at the present writing (Nov. 6th) have all become tubercled, as represented at Figure 40, *g*.

No doubt the insect passes the winter on the roots in this tubercled state, but whether in the spring these tubercled individuals produce winged males and females, which rise in the air, pair, and by depositing eggs give birth to the apterous females which found the gall-producing colonies; or whether, as spring opens, they lay eggs on the roots, and the young hatching from these eggs crawl up on to the leaves and found those gall-producing colonies, are questions yet to be settled in the life-history of our Grape leaf-louse. The former hypothesis is, however, by far the most probable, for analogy would lead us to infer that winged males and females must be developed at some time during its annual course, and winged males are so rare in the galls that I have never been able to find them, though I have opened thousands upon thousands of the galls during the summer and fall months. Dr. Shimer, indeed, is the only fortunate individual who has found the winged insect in the galls, and, as he himself tells us, he only succeeded in finding four specimens in the fall of the year, after cutting open ten thousand galls; and he has really given us no proof that his winged specimens were really males, and not females. Let us hope, however, that by pointing out the gaps in the biological history of this insect, attention will be drawn to them, so that they may be the more readily filled.

These discoveries lead us to some most important practical considerations. It now becomes evident that this insect can be transported from one place to another on the roots, either upon transplanted vines or in earth containing fibrous roots. Doubtless it was by some such mode as this that the insect was introduced into France from this country. It may be in this manner likewise that it has in part spread from one portion of our country to another, though as it is found indigenously on the wild Frost Grape, the greater probabilities are that it exists wherever this wild grape is found, and has gradually spread from it on to the cultivated varieties. These probabilities are strengthened by the fact that new grape wood is always rooted in the spring, when the lice, according to my views, are leaving the roots. But the important fact remains, that the insect winters on the roots, and that to exterminate it from a vineyard we have but to root up and destroy, late in the fall, such vines as were affected with the galls. From the poor success that has attended the experiments made abroad to destroy the lice on the roots, and from the fact that it is so difficult to reach them, I have little hope that any other remedy will be found than that of extermination by the means indicated, or by plucking and destroying the gall-infested leaves as fast as they appear in the spring.

Another very important practical lesson may be derived from the facts here mentioned, namely, that no variety of the Frost Grape (*V. cordifolia*) should be cultivated and encouraged where those of the Fox Grape (*V. labrusca*) or of the Summer Grape (*V. æstivalis*) are known to be as good. Some of our best grape-growers, especially in the Mississippi Valley, already discard the Clinton and its nearest relatives as worthless, and, considering its liability to this disease, we heartily commend their conduct.

At the 15th annual meeting of the Illinois State Horticultural Society, at Galesburg, the Clinton was highly recommended by Mr. D. B. Wier, of Lacon, Ills., principally for its vinous and medicinal qualities; but in this recommendation he did not meet with much support except from Dr. Hull the State Horticulturist, who also, in the course of his remarks sustained Mr. Wier in his recommendation of the Clinton, though in our own State Horticultural Report for 1864

(p. 66.) he is reported as being much inclined to discard it, his objection being that it is "troubled by the apple-worm"—by which is doubtless intended, the Grape-berry Moth.

There is some difference of opinion among botanists and experienced grape-growers as to the number of indigenous species of the Grape-vine, and as to the true character of some of the cultivated varieties. Some botanists are inclined to the opinion that we have but two, or even but one, species; and certain it is that the fertile character of the hybrids would lead to such an opinion, if infertility of hybrids is to be taken as a test of specific character. But it is more generally accepted that we have four distinct species (*V. labrusca*, *æstivalis*, *cordifolia* and *vulpina*) and this view is held by most western men,* and is perhaps warranted when we reflect that the very term species is but arbitrary, and that fertility of hybrids is not valued so much as an indication of specific identity among plants and some of the lower animals, as it is among more highly organized beings.

As already stated, our Grape leaf-louse is now principally confined to varieties of the Frost Grape;† but as it has been found in limited numbers on Iona and Concord, which are considered as varieties of the Northern Fox, and on the Delaware, which is considered either as a Summer Grape or as a hybrid between the Summer and the Northern Fox, I fear it may yet spread and become injurious to these species. Morever, now that we know that our insect is identical with that of Europe, there is also great danger that it will attack all hybrids with the European *Vinifera*, some of which, as the "Goethe," now promise well. Thus the reasons for discarding the Clinton and other Frost grapes become multiplied, for their cultivation may endanger the whole grape-growing interest of the country. On entomological grounds, I say emphatically to western men, do not plant any more Clintons, and get rid of those you now have as quickly as possible.

At the recent meeting of our State Horticultural Society at St. Joseph, some little discussion followed a paper which I read on this gall-louse and I was pleased to find that Dr. C. W. Spaulding, well known as a successful and experienced grape-grower, together with many other members, fully concurred in the advice here given. He had examined many of his vines, after his attention had been called to the matter, and found that the lice were found principally on the roots of old vines, and not on those of young ones. At this meeting it was almost unanimously agreed that the Clinton was comparatively worthless and should be done away with, but a few of the more

* See Husmann, "Grapes and Wine"; Flagg, *Hearth and Home*, Sept. 3, 1870; Spaulding, Lecture delivered at the Illinois State Fair, 1870.

† Though Gray considers the Clinton a variety of the *Æstivalis*, it is more generally considered as belonging to *Cordifolia*, which its great liability to the gall-louse would indicate.

conservative members, hesitated about discarding it for fear that such action would bring about the very result which it was intended to avoid, *i. e.*, the spread of the insect on to other and more valuable varieties. In other words they feared that by taking away the Clinton, the lice which now prefer this variety and flourish and multiply upon it, would be forced to attack other varieties. They looked upon the Clinton, as a protector to the better kinds, by drawing the lice away from them, arguing, to parady the words of Shakespeare, that

"'Tis better far, to bear those ills we have
Than fly to others that we know not of."

Now while I admire the cautious spirit manifested in such an argument and admit that it seems plausible, I cannot believe there is any logic in it. The argument presupposes that the louse, as a species, can suddenly change its habits and tastes when forced to do so; but to my mind, a new habit is not generally acquired in a species by the simultaneous change of all the individuals composing it, but by some aberrant individual first taking on the new habit, and transmitting that habit to its descendants until a new race is in time produced. A single Clinton vine may stand in the midst of a vineyard of Concords for years, and, as we know to be the case, may be badly infested with this louse without its spreading on to the surrounding Concords. The lice may, and perhaps do, year after year spread on to and settle on the comparatively tougher leaves of such Concords, but year after year they perish from incapacity to sustain themselves. Some day, however, one or more aberrant individuals, may, by some slight constitutional difference from the normal type, be enabled to sustain themselves on the Concord leaves, and, by the laws of inheritance, transmit their characteristics to their descendants until, by the survival of those from each generation best fitted to flourish on these leaves, a new Concord-feeding race will be produced. Therefore, as already stated, I believe that there is danger of this louse spreading on to other varieties, and especially on to such as are more closely allied to the *Cordifolia*, or, to use a common but inexact expression, that have *Cordifolia* "blood" in them. But it must not be forgotten that we are here only supposing, from analogy, what *may* occur, because we know not positively that it *will* occur, and it is very obvious that even if there is this danger the chances of such an occurrence will be far greater as long as the Clinton is allowed to grow in the vineyard, than when it is uprooted and banished; and so far as all experience goes, we can safely conclude that to destroy all those vines in a vineyard that are infested with this louse, is to banish it from such a vineyard so that it will in future confine its attacks to the wild frost, as it did in the beginning.

The Apple-maggot (*Trypeta pomonella*, Walsh), as Mr. Walsh has demonstrated,* is an indigenous American insect and breeds in our

*Report as Acting State Entomologist of Illinois, pp. 29–30.

wild haws, occurring abundantly in the West, as well as in the East. Of late years it has acquired an appetite for the cultivated apples in some of the Eastern States, where it already does much damage to the apple crop. Yet, strange to say, it has not yet, and may never attack the cultivated apples in the West, and there is more danger that in process of time the more civilized Apple-maggots of the East will spread to the West, than that our haw-feeding maggots which are now among us, will acquire that habit, as a race of them once did in the East. Now no one will argue that if the Apple-maggots of the East were to be exterminated, the maggots in the wild haws would any the sooner attack our cultivated apples; and in like manner the extermination of the lice on our Clinton vines will not cause those on the Wild Frost to any the sooner attack our Concords.

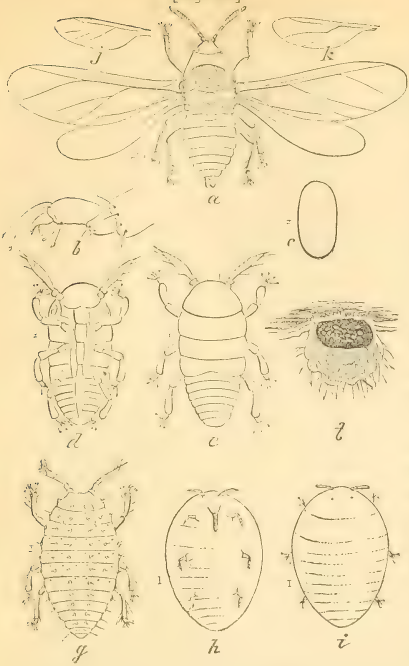
To give another illustration:—Our White pines have for years been greatly injured by the Pine-leaf Scale (*Aspidiotus* [*Mytilaspis*] *pinifoliæ*, Fitch) and I know that this same scale occurs to a slight extent on several other species of the genus, and have good reason to believe that it (or a race of it) is becoming more and more numerous on the Scotch pine around St. Louis. Yet to get rid of this scale I would not hesitate to destroy such White pines as were infested with it, for fear that by such a procedure I should drive the scales on to any other pines; because I believe that the scales on the Scotch pine for instance, multiply among themselves rather than by the annual transportation of individuals from the White pine, and because the experience of the past teaches that the latter is the only pine which has really suffered injury from this scale.

Other similar illustrations might be given, but I close by reiterating the opinion that there is nothing in the past history of the Grape-leaf Gall-louse to warrant the belief that by destroying the Clinton we shall force it on to those more valuable varieties which it has not hitherto attacked, and that whenever, as is admitted to be the case in the central portion of our State, the Clinton can be replaced by other and better varieties, it will be most wise and judicious to discard it. I have no idea that we shall ever exterminate this louse from our vineyards, because we can never obtain concert of action all over the country, and because it will flourish in a measure on other cultivated varieties of the *Cordifolia* group. But let each individual act for himself, and I feel satisfied that so far as he follows the advice here given, just so far will he be benefited.

There are several cannibal and parasitic insects which attack this Gall-louse, but for lack of time to make the proper illustrations, I shall have to leave their consideration to a future Report.

Figure 39, at the head of this article, represents a leaf covered with galls. Figure 40, (*a*) represents the winged female; (*b*) her foot or tarsus—after Signoret; (*c*) an enlarged egg; (*d*) the newly hatched gall-inhabiting type, ventral view; (*e*) same, dorsal view; (*f*)

[Fig. 40.]



a section of a gall; (*g*) the tubercled root-inhabiting form; (*h*) the mother gall-louse at the heighth of her fertility, ventral view; (*i*) same, dorsal view—all from nature; (*j* and *k*) differently veined wings of the Oak *Phylloxera* of Europe. All these figures are greatly enlarged, and the natural size is approximately shown by hair-lines.

The following discussion of this insect's proper place in our classification, and of its characters, may be passed over by the practical reader, as it is intended for those only who take an interest in such questions. I append it with but very slight alteration, as I wrote it for the last number of the second volume of the *American Entomologist*:

It will be remembered that in what was said about this insect on page 248 of our first volume we criticized the founding of the Family *Dactylosphæridæ* by Dr. Shimer. In an essay read before the Illinois State Horticultural Society, at Ottawa, last winter, Dr. Shimer took exception to our remarks, and called upon us to give a reason for the faith that is in us. Not considering a horticultural meeting the proper place to enter into the discussion of purely entomological questions, we declined to waste the precious time of the members, but intimated that we should be glad to answer the Doctor whenever a favorable occasion presented. The opportunity did not offer till now, as the Transactions of the Society, containing the essay in question, have but recently been published, but as we ourselves wrote the strictures, we will briefly give our reasons for so doing. In order to lay the question clearly before those interested, it will be necessary to quote that portion of our former article which so exercised friend Shimer. It runs as follows:

The louse which forms the gall was first described as *Pemphigus vitifoliæ* by Dr. Fitch, of New York, though it does not belong to that genus. Dr. Shimer, of Mt. Carroll, made some interesting observations on the habits of this insect, and made it the type of a new family (*Dactylosphæridæ*) and of a new genus (*Dactylosphæra*.) The distinguishing features of this supposed family are certain appendages attached to the legs which Dr. Shimer calls *digituli*, though the characters of the wings point unmistakably to the genus *Phylloxera* of the true Plant-lice. We shall not now discuss the validity or propriety of this new family, as we intend to give a more complete account of this louse in our future articles on Grape insects; but we will say here that Dr. Shimer is unfortunate in grinding out new genera and new families, for he has proposed a new family and genus (*Lepidosaphes*) for the common Apple-tree Bark-louse (*Aspidiotus*) [*Mytilaspis*] *conchiformis*, Gmel.) based upon similar appendages, which he found on its legs; whereas, if he had been better posted he would have known that these appendages are characteristic of almost all Bark-lice.

And here is Dr. Shimer's appeal:

Here they would like to make the public belive that these appendages, *digituli*, are the characters out of which I have proposed two families in Entomology; whereas, the leading character upon which I propose my family *Dactylosphæridæ*, is two claws on a one-jointed tarsus, and the leading characters in *Lepidosaphidæ* are a tarsus without a claw, and a *scale-making*, not a scale-like insect. The *digituli* from their globe-ended extremities I consider of some importance, but by no means of primary weight in the first named family, and in the second family I give them no more than secondary importance. What reasons the junior editor, for he alone now becomes responsible, can assign for so gross a misrepresentation I am not able to anticipate. He certainly, however, will be able to give some reason for the faith within him. * * * * * * I have not the slightest personal feeling in the matter, and I hope that my much respected friend, Mr. Riley, State Entomologist of Missouri, will be free to defend the position he has taken against me.

Now, we believe Dr. Shimer is sincere in stating that he has no personal feeling in the matter, else we should not even notice his request. We hope, therefore, that he will believe us when we state that in the few words we are about to pen we are governed by no personal considerations whatever, but by a love of truth for truth's sake. As Dr. Shimer becomes more familiar (and we hope he will so become) with the minute and interesting insects to which he has more especially turned his attention, he will no doubt regret that he ever proposed those two families without longer pondering and considering.

Regarding the Bark-louse, we will dismiss the subject in a few words, as it is foreign to the topic under consideration. Dr. Shimer, it is true, deserves severe handling for the cool and skeptical manner in which he refers to the work of all preceding entomologists, and the laughable way in which he arrogates to himself the power of correct observation;* but at present we will simply accede to his request, as follows:

We confess that in stating that Dr. Shimer had based his new family, LEPIDOSAPHIDÆ, upon the occurrence of *digituli*, we should have qualified our language by inserting "partly" before "upon," since the characters as given by him are, *"Four digituli terminated by pulvilli or arolia, and no claw, and the female living beneath a scale or shell-like habitation of her own constructing."** But we insist that the proposition of a family on such grounds was not only unfortunate, but unwarranted, for the following reasons: First, the so-called *digituli* are not even of generic, much less of family value, as they are nothing but modified hairs, and occur in a more or less perfect form in all young *Coccidæ* and *Aphidæ* which we have examined, and are acknowledged by the best authorities to be common to both these families. Secondly, the insect in question really has a more or less perfect claw, as we have abundantly demonstrated the present year. Thirdly, the assumption† that the scale in all COCCIDÆ should be part and parcel of the insect itself, is a purely gratuitous one, since there are many other species which live separate from their scales, and since the genus *Aspidiotus* was especially erected by Bouché for those species which thus live *under* and seperate from them. Consequently there remains not a single character mentioned by our author but what is well known to belong to the COCCIDÆ, and there is not even the slightest excuse imaginable for seperating it from Costa's genus *Diaspis*, to which it is now correctly referred by Signoret—our highest authority on this family.

Now let us return to our Grape-leaf louse. We have no trouble in proving by Dr. Shimer's own words that we were perfectly justified in saying that the "*digituli*" were the "*distinguishing* features" of his supposed family *Dactylosphæridæ*. The very meaning of the word (globe-fingered) given to the family indicates such to have been the case, and he himself expressly says:‡ "The wing neuration of *Dactylosphæra* is synonymous with that of *Phylloxera*; it is, therefore, upon the other characters that I found this genus." Now what are the other characters? Turning to the family characters given, we find: "Wings four, carried flat on the back in repose. Antennæ few-jointed. Tarsi composed of one joint terminated by two claws, and from two to six *digituli*. Honey tubes none; otherwise resembling *Aphidæ*."§ The only other character given which is not Aphidian is the one-jointed tarsus, which, as we shall presently show, cannot, strictly speaking, be considered a character of our Gall-louse, and which, even if it were, would scarcely warrant the making of a new family. Every other character, including the "*digituli*," is common to dozens of plant-lice, and the neuration of the insect's wing‖ places it beyond any doubt in the genus *Pyllox-*

*Trans. Am. Ent. Soc. I, pp. 371-2.

* Trans. Am. Ent. Soc., I, p. 372.

† Ibid, p. 371.

‡ *Characters for a supposed new family*, p. 5, note; from the Proc. Acad. Nat. Sci., Phil., Jan., 1867.

§ Ibid, p. 1.

‖ The neuration of the wing differs slightly from the typical European *Phylloxera quercus*, in the two discoidal veins of the front wing uniting in a fork instead of being perfectly separated. On this account Mr. Walsh proposed for our insect, and for certain other species found in hickory galls, which have the same neuration, the generic name of *Xerophylla*. But it seems to us that the polymorphism of APHIDÆ has not yet been sufficiently investigated to allow of making even different species, much less different genera, upon a forked or unforked nervure, for there is frequently much greater difference in specimens coming from the same parents; and, as we are informed by M. Lichtenstein, the European *Phylloxera* of the Oak actually presents both kinds of neuration;

era, which has long been ready to receive it, and which, with the genera *Vacuna* and *Chermes*, form the sixth Tribe, *Chermesinæ*, of the APHIDÆ, according to Passerini's latest revision of this family.

We can commend the carefulness with which Dr. Shimer made the interesting observations which he has given us on this insect, but no man should undertake to found new families without first informing himself more thoroughly of what has already been done by others.

It was by no very easy means that we arrived at the conclusion that our Gall-louse is identical with the European species, but now that the fact seems sufficiently proved, Planchon's specific name *vastatrix* will have to give way to Fitch's *vitifoliæ*,* or at the most be retained as a variety.

At first there seemed to be many reasons for considering the two insects distinct. First, the European root-louse was exceedingly destructive, and their gall-louse of only exceptional occurrence; while our gall-louse was very common and destructive, and no root-lice were known to exist here at all. Secondly, the insect found in the galls was smooth, while that on the roots was distinctly ornamented with piliferous tubercles, and the two were sufficiently unlike to cause M. Lichtenstein, who believed in their identity, to propose the term gall-inhabiting (*gallicole*) for the one race, and root-inhabiting (*radiciole*) for the other. Thirdly, our insect was described as having a one-jointed tarsus, whereas M. Signoret described and figured the tarsus of the winged root-inhabiting form as two-jointed. Fourthly, there seemed to be a difference even in the form o our gall-inhabiting louse and theirs, as ours appeared much more obese and globular than theirs, as represented in their figures. All these apparent differences were rather calculated to give rise to doubts as to the identity of the two insects; but by careful observation and persistency we have been enabled to dispel them all.

First, we might naturally expect—and those who believe in the Darwinian hypothesis certainly would—that, presuming our insect to have been imported into Europe, it would undergo some modification in its habits, not only because of change of climate, but because of its having to live on another species of the Grape-vine—all the European species belongs to *Vitis vinifera*. Hence its normal habits there, of feeding on the roots, may have been gradually acquired. We believe a parallel case presents itself in our Apple Root-louse (*Eriosoma pyri*, Fitch) and the Wooly Aphis, or so-called "American Blight" (*Eriosoma lanigera*, Hausm). It is conceded on almost all sides† that the last insect was imported into Europe from this country, and there is now every reason to believe that the two insects are identical, or that at furthest they can only be considered as varieties of one species. Yet while in this country our root-louse is very injurious in the West, and only exceptionally found on the limbs above ground (though more often so found in the Eastern States); all authors that we are acquainted with have spoken of it as occurring solely on the limbs in Europe; though M. Lichtenstein informs us that he has found it on the roots also, and that in those cases it caused just such swellings of the roots as our root-louse does here. We know in St. Louis of an old apple-tree, standing in a yard where the ground is trodden hard, the limbs of which have been for the past three years more or less affected with this insect, though none can be found on the roots. But where the ground is more porous, and not so closely pressed to the roots, it seldom occurs on the branches, but often on the roots, even in the immediate neighborhood. Upon the closest examination we cannot find the slightest difference between the root and branch-inhabiting lice,

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there being red specimens with unforked nerves (Fig 40, *j*) and yellow specimens with forked nerves (Fig. 40, *k*). I have in my possession the very drawing made by Mr. Cresson from Dr. Shimer's specimen of *vitifoliæ*, which Mr. Walsh refers to in his Report, and which led Mr. W. erroneously to place our louse with the Coccids. The drawing is rough, evidently imperfect, and well calculated to mislead, for the discoidal nerve of the front wing is represented more as a fold, the forks are omitted, and the costa of hind wing is represented perfectly straight. The drawing is also accompanied by Mr. Cresson's statement that he could not give any decided opinion as to the neuration, as the wings on the specimen were not spread out.

* M. J. Lichtenstein has objected to Fitch's specific name "*vitifoliæ*" on the score of its being ungrammatical, and has substituted the term "*vitis-folii*" in his published reports. Now Dr. Fitch has given the termination "*foliæ*" to a number of his specific names, and though "*folii*" would of course be more grammatically correct, one would suppose the Doctor had some reason for his conduct. At all events, I believe it is perfectly proper to drop the middle *s* in compounding the two words, and certain it is that Fitch's term has been adopted by all subsequent writers in speaking of the insect. Irregularities in entomological nomenclature seem to be allowable, or at least are very frequently and purposely perpetrated for the sake of euphony. "Whatever is, is right," is as true in language as it is in religion, and if we alter *vitifoliæ* we must alter a thousand other entomological names that are not, strictly speaking, grammatically correct. It is quite proper to correct a faulty name, but after showing that it is faulty it seems best, to prevent endless confusion, to adopt the faulty name, and thus make its author shoulder the blame, until he himself corrects it.

† M. Eudes-Deslongchamps and M. Blot are the only authors, according to Amyot and Serville, who believe it is indigenous to Europe.

and no doubt their habitat is governed somewhat by the character of the soil, though in this country their normal habit is to attack the roots, and to appear above ground only occasionly in the fall.

Secondly, we have proved, by transferring on to roots the young grape-lice hatched from galls, and by successfully feeding them on those roots, that our smooth gall-inhabiting type gives birth to the tubercled root-inhabiting type; and we have discovered that our gall insects take to the roots in the fall, on which they cause the same cankerous spots and swellings as does the *vastatrix* of Europe, and on which they evidently hibernate just as *vastatrix* is known to do.

Thirdly, although in the gall-inhabiting type, in both countries, the tarsus seems to be one-jointed, yet in the root inhabiting type it is really two-jointed; for though the basal joint is small, and not visible from above, it is plainly visible from the side or from below (See Fig. 40, *b*). We have here what certain speculative entomologists would consider an excellent illustration of the inferiority of Coccidæ compared with the Aphidæ, namely, a true Aphidian, exhibiting in its larval and agamic stage the one-jointed tarsus of a Coccid, and only showing the two-jointed tarsus of its family in the more perfected tubercled form, and in the winged state. And this Coccid-affinity in the less perfect gall-producing state is sometimes carried still farther, as we have often been unable to discern but a single claw to the tarsi of some of the young gall-inhabiting individuals.

Fourthly, the fact that M. Signoret, who alone has compared actual specimens from both countries, decides them to be identical, would sufficiently indicate that the difference noticeable in the form depends on the observer, and on the stage of growth at which observations are made.

It was the one-jointed tarsus in the gall insect which no doubt in part led Dr. Shimer to propose a new family for it, and it was this character—coupled with the facts that it is oviparous, that does not secrete any sugary or flocculent substance (as do most gall-inhabiting Plant-lice), and that the young forsake the gall and scatter over the leaves as soon as hatched—which led Mr. Walsh to consider it as an anomalous and aberrant Coccid. The genus *Phylloxera* seems also, according to Westwood, to have been doubtingly introduced into this family by Curtis in his Guide. We have already shown that, in the root-inhabiting form, the two joints of the tarsus are plainly to be seen; and Dr. Shimer himself admits* that, in the winged insect which he found in galls, he noticed a constriction on the under side of the tarsus, though he is unwilling to allow that it was a joint, because there was no motion. But even if the 2-jointed character of the more perfect ouse were not demonstrated, all the other characters are so unmistakably Aphidian that there is, we think, no warrant in making a new family. In such degraded insects, where the antennal joints are so variable, we might naturally expect to find variation in the joints of the legs. The more familiar we become with the biological secrets of Nature, the more do we find, not only species but genera, and even families, approaching each other through modifications found in individuals; and these aberrant gall-lice only help to give us a better idea of the close connection between the *Coccidæ* and *Aphidæ*. Our *Phylloxera* brings the two families close together, by its affinities on the one side with *Chermes* of Linnæus, which, though looked upon as a Coccid by Ratzeburg, is generally considered an Aphidian, and on the other with the Coccidan genus *Dactylopius* which contains Linnæus's *Coccus adonidum*. The oviparous nature of these gall-lice will also have less significance when we reflect that there is a sort of gradation in this process, and that many Plant-lice which are considered viviparous or ovoviparous do in reality bring forth their young enveloped in a more or less distinct egg-like film or covering, from which they have to free themselves by a process analogous to that of hatching. This has not only been observed by Curtis, in the case of an *Aphis* found on the turnip,† but by Dr. Wm. Manlius Smith, of Manlius, N. Y.,‡ in the case of *Pemphigus*; but we have, the present year, assured ourselves of the accuracy of Dr. Manlius's observation as to *Pemphigus*, and witnessed the same thing in *Eriosoma*, namely in *E. pyri*, Fitch. In this last case the newly deposited louse (or egg) remains motionless for a considerable time; and the covering, after the young louse has extricated itself from it, may be as distinctly seen attached to the end of its body as the covering or egg-shell of our Grape gall-louse, and was figured by Fitch, who mistook it for the cotton-like matter, which, however, is not secreted till the louse fastens itself and begins to grow.§ Moreover those Aphidians which are viviparous through the spring and summer months, generally lay eggs in the fall; and though agamous and viviparous multiplication can be prolonged by submitting the lice to a continued artificially warm temperature, there is doubtless a limit to this prolongation; and it may be laid down as a rule that, with most Aphidians, the ♂ element and the production of eggs are, at some time or other, indispensable to the continuance of the species.

*Characters of a Supposed New Family, p. 3.

†Farm Insects, p. 65.

‡Auctore Walsh, P. E. S. P. VI, p. 282, note.

§N. Y. Rep. I, p. 9.

THE COLORADO POTATO BEETLE AGAIN.

THE BEST MEANS OF FIGHTING IT—A WORD TO OUR CANADIAN NEIGHBORS.

To give some idea of the onward march of this destructive insect, and to lay before the reader the experience that has been gained since the publication of my first Report, I transmit the following article from the *American Entomologist* of last September.

Last July, while spending a few days in Ontario, we ascertained that this most destructive insect had just invaded the Dominion at two different points, namely, near Point Edward, at the extreme south of Lake Huron, and opposite Detroit, near Windsor, at the south-western corner of Lake St. Clair. These are precisely the two points at which we should naturally expect to first meet with it on the Canadian border; for all such beetles as fly into either of the lakes from the Michigan side would naturally be drifted to these points. As we know from experience, many insects that are either quite rare, or entirely unknown on the western side of Lake Michigan, are frequently washed up along the Lake shore at Chicago; and these are so often alive and in good condition, and so often in great numbers, that the Lake shore is considered excellent collecting ground by entomologists. In like manner grasshoppers are often washed up on the shores of Salt Lake, in Utah, in such countless numbers that the stench from their decomposing bodies pollutes the atmosphere for miles around. We have not the least doubt, therefore, in view of these facts, that the Colorado Potato Beetle could survive a sufficient length of time to be drifted alive to Point Edward, if driven into Lake Huron anywhere within twenty or thirty miles of that place, or if beaten down anywhere within the same distance while attempting to cross the lake.*

How truly is Mr. Walsh's prophecy being fulfilled, that the northern columns of this great army would spread far more rapidly than the lagging southern columns.†

Now, what will our Canadian brethren do? Will they stand by and listlessly see this pernicious insect spread over their territory like a devouring flame, as it has done over the Western and Central States; or will they make some determined and united effort to prevent such a catastrophe? Of one thing our friends across the border may rest assured—they have not here a sham and braggart Fenian army to deal with, but an army which knows no retreat, and whose

*The following item which was clipped from the St. Joseph (Mich.) *Herald*, after the above was written, attests the accuracy of the inference :—"Whoever has walked on this shore of Lake Michigan has observed large numbers of the Colorado potato beetle, crawling from the water. Many have doubted the source whence they came. It would seem from the following that they fly, and swim from the western shore of Lake Michigan. Capt. John Boyne of the Lizzie Doak, reports finding his deck and sails infested with potato bugs when half way from Chicago to St. Joseph at night. Not a bug was on deck when the schooner left Chicago."

†*Practical Entomologist*, I, p. 14.

embers, though of small and insignificant stature, will fully make up in number what they lack in size.

When we calculate the immense loss, amounting to millions of dollars, which this insect has cost the Western States during the past nine or ten years—when we contrast the healthful and thrifty aspect of the potato fields in Ontario and in those States to which this potato plague has not yet spread, with the sickly, denuded, or Paris-green-besmeared fields at home—but above all when we reflect that, nothing preventing, it will infest the whole of Ontario within, perhaps, the next two, and at farthest within the next three years—we feel that it is high time to make some effort to prevent its onward march through Ontario, if ever such an effort is to be made. The warnings and instructions given by the Agricultural press, and through our own columns, will avail but little, as they reach the few only. It may be, and doubtless is, true that successful culture, as our country becomes more thickly settled, will be confined to the intelligent and well-informed; yet the fact nevertheless remains, that the masses will do nothing to ward off an evil until they are forced to it from necessity. The plodding, non-reading farmer will take no notice of the few bugs he first sees in his potato field, because they do him no material injury; but when the bugs have increased so as to make it a question of "potatoes or no potatoes" with him, then his energies will be aroused. But alas! his best efforts, at this time, often prove unavailing, and he has to spend days to accomplish that which a few minutes would have accomplished before. We therefore fully expect to see this great army of bugs continue its eastward march without hindrance, unless other preventive measures are taken than those already employed. A standing premium offered by the Minister of Agriculture, Mr. Carding, for a given number of beetles, or for the greatest number collected and killed in one season, or for the cleanest and best field of potatoes, of a given number of acres, within the infested districts along the eastern shores of the lakes mentioned and those of the St. Clair river; might, and undoubtedly would, be the best means of stamping it out, and of keeping it out of the Dominion.*

No doubt that, in suggesting any expenditure of money for such purposes, our Canadian brethren will deem us over-enthusiastic about "small things," and over-anxious for their welfare. Well, be that as it may, we don't forget that there is considerable of Uncle Sam's territory beyond Niagara. It is a mere matter of dollars and cents, and we venture to say that, when once this insect shall have spread over Ontario, a million dollars would be freely spent to accomplish that which will then be almost impossible, and which a very few thousands would effectually accomplish now—namely, its extermination from the Dominion.

An excellent chance is now afforded in Ontario—almost surrounded as it is by lakes—to keep this destructive enemy at bay. In the summer of 1869, reports of this insect's ravages, and of its progress eastward, came thick from Wisconsin and Indiana; but no organized effort was made to check it, and indeed there was very little chance of doing so. It is fast spreading through Ohio; and according to Dr. Trimble of New Jersey, has already reached Pennsylvania. Uncle Sam cannot well prevent its spread around the southern shore of Lake Erie, through Pennsylvania and eastward; but, if it can be effectually resisted between Point Edward and the Detroit river, there will be little difficulty in preventing its crossing at Niagara. A victory would indeed be gained if, by intelligent effort, this grievous pest could be kept out of Upper Canada, while it is devastating the potato fields on all sides in the States; and Minister Carding would add to his well-deserved popularity by making the effort, whether it succeeds or not.

PARIS GREEN A REMEDY.

While on this subject it may be well to say a few words about the use of Paris green. This substance has now become THE remedy for the Colorado Potato Beetle, and it is the best yet discovered. Having thoroughly tested it ourselves, and having seen it extensively used, we can freely say that, when applied judiciously, it is efficient and harmless. If used pure and too abundantly, it will kill the vines as effectually as would the bugs, for it is nothing but arsenite of copper (often called "Scheele's green" by druggists), and contains a varied proportion of arsenious acid, according to its quality—often as much as fifty-nine per cent., according to Brande & Taylor. But when used with six to twelve parts, either of flour, ashes, plaster or slacked lime, it causes no serious injury to the foliage, and just as effectually kills the bugs. The varied success attending its use, as reported through our many agricultural papers, must be attributed to the difference in the quality of the drug.

We hear many fears expressed that this poison may be washed into the soil, absorbed by the rootlets, and thus poison the tubers; but persons who entertain such fears forget that they themselves often apply to the ground, as nourishment for the vines, either animal, vegetable or mineral substances that are nauseous, or even poisonous to us. Animal and vegetable substances, of whatsoever nature, must be essentially changed in character and rendered harmless before they can be converted into healthy tubers, and a mineral poison could only do harm by being taken with the potatoes to the table. That any substance, sprinkled either on the vines or on the ground, would ever accompany to the table a vegetable which develops underground, and which is always well cooked before use, is

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* The Rev. C. J. S. Bethune, in the *Canada Farmer* for October 15th, 1870, also recommended the marking off of a tract of country about ten miles in width, all along the border line between the foot of Lake Huron and the head of Lake Erie, with the exception, possibly, of a portion of the eastern shore of Lake St. Clair, and stopping the culture of the potato throughout that whole tract during the prevalence of the pest in the neighboring State of Michigan.

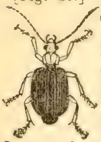
rendered highly improbable. There can be no danger in the use of sound tubers. But the wise and well-informed cultivator will seldom need to have recourse to Paris green, as he will find it more profitable to use the different preventive measures that have from time to time been recommended in these colums.

The poison may do harm, however, by being carelessly used, and it is most safely applied when attached to the end of a stick several feet long, and should not be used where children are likely to play.

NATURAL CHECKS INCREASING.

In many parts of the West this insect is being kept in due check by its cannibal and parasitic enemies, which are still increasing. Thus we learn from many sources that in Iowa and Kansas it is not nearly so injurious as it formerly was, while in some parts of Illinois and Missouri it has also become less troublesome. Last year Mr. T. Glover published the fact that the Great Lebia (*Lebia grandis*, Hentz, Fig. 41) was found devouring its larvæ,* and though hitherto considered rare this Lebia has suddely fallen upon it the present year in many parts of Missouri. During a recent trip along the Missouri Bottom we found this cannibal very abundant in some potato fields belonging to Mr. Wm. Coleman, where it was actively engaged in destroying both the eggs and larvæ of the Potato Beetles. The head, thorax and legs of this cannibal are yellowish-brown, in high contrast with its dark-blue wing-covers.

[Fig. 41.]



This makes fourteen conspicuous enemies of our Colorado Potato Beetle which we have figured, and a dozen more, mostly of small size and inconspicuous markings, might easily be added to the list. Moreover, chickens have learned to relish the eggs, and have even acquired a taste for the young larvæ. So we need not wonder that the army is being decimated in those States first invaded by it.

BOGUS EXPERIMENTS.

It was recently reported to us that a neighbor had succeeded in driving away all his Potato bugs by strewing Elder branches among the vines. We went to examine the field and found our friend enthusiastic over his discovery; and indeed though the vines were nearly devoured, there were but a few full grown larvæ to be found. But, as he could not tell us what had become of the "slugs," we undertook to show him where they had gone, and after digging a few moments with a trowel, unearthed dozens of them, the majority in the pupa, but a few yet in the larva state. Our neighbor had, in fact, been misled by appearances, for want of better knowledge of his enemy. The larvæ as they acquired their growth suddenly became so destructive, that to save his vines he was obliged to try some means of killing them,

* Dept. of Agr. Rep. 1868, p. 81.

and as an experiment he tried the Elder. The larvæ were just ready to disappear of their own accord, and as the great bulk of them did really disappear in two or three days after the application, the apparently logical inference was made that they had been driven away by the smell of the Elder.

How many of the published remedies that flood the country owe their origin to just such defective proof! The sun-scorching remedy, which consists of knocking the bugs off the vines on to the heated ground between the rows, and which has been so often recommended the present year, partakes a good deal of this character; for it can only be of benefit in a very dry season, and at a time of year when the bugs have done most of their damage. A goodly proportion of the larvæ that are thus knocked off will always manage to burrow into the ground and transform, or to get back upon the vines; and

THE TRUE REMEDY

consists in preventing them from becoming numerous so late in the season. Watch for the beetles in early spring, when the vines are just peeping out of the ground. Ensnare as many of them as you can before they get a chance to pair, by making a few small heaps of potatoes in the field planted: to these the beetles will be attracted for food, and you can easily kill them in the morning. Keep an eagle eye for the eggs which are first deposited. Cultivate well, by frequently stirring the soil. Plant early varieties in preference to late ones because the bugs are always more numerous late in the season than they are during the spring and early summer. Give the preference to the Peach Blow, Early Rose and such other varieties as have been found most exempt from attack,* and surround your fields on the outside by rows of such tender-leaved varieties as the Mercer, Shaker, Russet, Pink-eye and Early Goodrich; but, above all, isolate your potato field as much as possible, either by using land surrounded with timber, or by planting in the centre of a cornfield. Carry out these suggestions thoroughly and you will not have much use for Paris green and still less for the scorching remedy.

THE CODLING MOTH AGAIN.—*Carpocapsa pomonella*, Linn.

HAY-BANDS VS. RAGS—ALWAYS TWO-BROODED IN MISSOURI.

After a series of experiments, instituted the past summer, I have proved that, after all, the hay-band *around* the trunk of the tree is a

* After experimenting last summer with eighty-one varieties of potatoes, the Superintendent of the garden of the Iowa Agricultural College reports the varieties of the Peach Blow, the Peerless and Chili No. 2, as most exempt from the ravages of this insect, the last named variety not being worked upon at all.

more effectual trap for the Apple-worm than the rags placed in the *fork* of the tree. There is no superiority in the rags over the hay-band, unless the former are made to encircle the tree as thoroughly as the latter. Where rags are placed simply in the forks, many of the worms pass down the tree from the outside of the branches. If the rag is tied around the trunk, it will impede almost every worm that crawls down the tree from the fruit which hangs on, or that crawls up the trunk from the fruit which alls; and it then has a decided advantage over the hay band, because it can either be passed through a roller or scalded, and used again.

It has been very generally accepted in this country that the Codling Moth is double-brooded, and in all my writings on the subject I have stated it to be so, though no one, so far as I am aware, ever proved such to be the case beyond a doubt. Mr. P. C. Zeller, of Stettin, Prussia, informed me last winter that it is only single-brooded in that part of the world, and Harris gives it as his opinion that it is mostly so in Massachusetts. Now, such may not improbably be the case in northern Prussia, and the more northern of the United States, though I incline to believe otherwise. At all events, this insect is invariably double-brooded in the latitude of St. Louis, and its natural history may be briefly told as follows: The first moths appear, and begin to lay their eggs, soon after the young apples begin to form. The great bulk of the worms which hatch from these eggs leave the fruit from the middle of May to the middle of June. These spin up, and in from two to three weeks produce moths, which pair and in their turn commence, in a few days, to lay eggs again. The worms (second brood) from these eggs leave the fruit, some of them as early as the first of September, others as late as Christmas. In either case they spin their cocoons as soon as they have left the apples, but do not assume the pupa state till towards spring—the moths from the late matured worms appearing almost as early as those from the earlier matured ones. The two broods interloc so that in July worms of both may be found in the fruit of one and the same tree. I have repeatedly taken worms of the first brood, bred the moths from them, and obtained from these m ths the second brood of worms; and I have done this both on enclosed fruit hanging on the tree in the open air, and on plucked fruit in-doors. In the latter experiments the moths would often cover an apple with eggs, so that when the worms hatched they would enter from all sides, and soon so thoroughly perforate and devour the fruit as to die of starvation. This is a clear case of misdirected instinct in the parent, caused doubtless by confinement.

From the foregoing facts, it becomes obvious that the rags or the hay-band should be kept around the tree, say from the first of May till the fruit is all off; and to be thoroughly effectual, the insects collected in or under them should be destroyed regularly every fortnight during that time.

There is a fact connected with the Codling Moth which, though of interest to entomologists is not generally known, and has never been published in this country. It has always been difficult to distinguish the sexes of this moth, but there is an infallible index recently pointed out by Mr. Zeller in his "Lepidopterologische Beobachtungen im jahre 1870." It consists of a black pencil or tuft of hairs of considerable length on the upper surface of the hind wings. It springs from a point close to the base of the wing and by the side of the median nervure, and lies in a groove running alongside of that nervure to about half the width of the wing, the groove forming a distinct carina on the under surface. The tuft when closely fitted into this groove is not easily noticed, but since my attention has been drawn to it, I have readily detected it on all my cabinet specimens, and it can easily be raised by the point of a needle.

Thus we find that important features are often revealed upon close scrutiny of our commonest insects, and the fact that this feature was so long overlooked in our Codling Moth should teach us to be all the more careful and cautious in our examinations and descriptions. Two similar instances of general oversight of common features in common insects were pointed out to me last fall by that excellent observer, Mr. J. A. Lintner, of the Agricultural Rooms, Albany, N.Y., who ascertained the facts that in the Butterfly genus *Argynnis* the males have invariably a beautiful fringe of hair on the sub-costa of the hind wings, while the females have not; and that in the genus *Grapta* the males have hairy front legs while the females have not.*

In my first Report (p. 65) I mentioned as an exceptional occurrence that this insect had been found quite injurious to plums around London, Ontario; but it has not hitherto been recorded as infesting peaches. Mr. Huron Burt, of Williamsburg, Callaway county, informs me, however, that three-fourths of the peaches in his vicinity were infested with this worm, and that it was more abundant in this stone-fruit than in apples, though its gnawings in the former are not followed by the same serious consequences as they are in the latter. In the peach the worm always lives near the stone, and bores no other holes through the flesh than the one required for egress, and the excrement is packed close to the stone, so that the fruit is generally but little injured for eating, cooking, drying or other purposes. Mr. Burt did not actually breed the moths from these peach-inhabiting worms, but as he is one of my most valued correspondents and an excellent observer and has paid considerable attention to insects, I have little doubt but that he is correct in concluding that they were the larvæ of the Coddling Moth, the more especially as he has fur-

* The first mentioned feature, as a secondary sexual character, has long since been pointed out, and according to Mr. H. W. Bates (Trans. Linn. Ent. Soc., Vol. XXIII, p. 502, 1861) is common to all the tropical genera but two (*Lycorea* and *Ituna*) composing the Danoid *Heliconidæ*. Yet Mr. Lintner's observation is certainly original in this country, for, striking and useful as the feature is as a sexual characteristic, it is never given in the beautiful plates of Mr. Edwards's "Butterflies of North America."

nished me, in detail, his reasons for this conclusion; but until the matter is settled beyond all doubt it would be premature to speculate farther on such a new and remarkable habit in such a common and well known insect.

THE CORN-WORM *alias* BOLL-WORM—*Heliothis armigera*, Hübner.

(Lepidoptera, Noctuidæ.)

This is a worm which is every year more or less destructive to our corn in the ear, and which was this year very injurious in many sections.

It has a very wide range, and a Mr. Bond, at the meeting of the London (England) Entomological Society, on March 1st, 1869, exhibited specimens of the moth from the Isle of Wight, from Japan, and from Australia; and, as might be expected from its extended habitat, the insect is a very general feeder. The "Boll-worm" has become a by-word in all the Southern cotton-growing States, and the "Corn-worm" is a like familiar term in those States, as well as in many other parts of the Union; but few persons suspect that these two worms—the one feeding on the corn, the other on the cotton-boll—are identically the same insect, producing exactly the same species of moth. But such is the fact, as I myself first experimentally proved in 1864. It attacks corn in the ear, at first feeding on the "silk," but afterwards devouring the kernels at the terminal end; being securely sheltered the while within the husk. I have seen whole fields of corn nearly ruined in this way, in the State of Kentucky, but nowhere have I known it to be so destructive as in Southern Illinois. Here, as in our own State, there are two broods of the worms during the year, and very early and very late corn fare the worst; moderately late and moderately early varieties usually escaping. I was formerly of the opinion that this worm* could not live on hard corn, and it certainly does generally disappear before the corn fully ripens, but last fall Mr. James Harkness, of St. Louis, brought me, as late as the latter part of October, from a corn field on the Illinois bottom, a number of large and well ripened ears, each containing from one to five worms of different sizes, subsisting and flourishing on the hard kernels. This is, however, an exceptional occurrence, brought about, no doubt, by the long protracted warm weather which we had, and the worms were in all probability a third brood.

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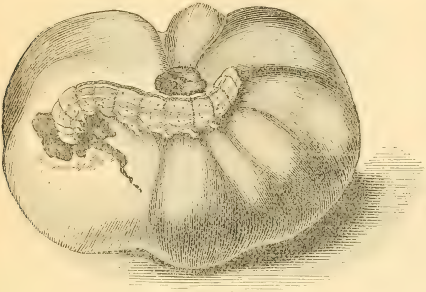
* Am. Ent. I, p. 212.

This glutton is not even satisfied with ravaging these two great staples of the country—cotton and corn—but, as I discovered in 1867, it voraciously attacks the tomato in South Illinois, eating into the green fruit, (Fig. 42), and thereby causing such fruit to rot. In this manner it often causes serious loss to the tomato-grower, and it may justly be considered the worst enemy to the tomato in that section of the country. Mr. Glover also found it feeding in a young pumpkin, and it has been ascertained by Mrs. Mary Treat of Vineland, New Jersey, not only to feed upon the undeveloped tassels of corn and upon green peas, but to bore into the stems of the garden flower known as Gladiolus, and in confinement to eat ripe tomatoes. Last summer it was also found by Miss M. E. Murtfeldt in common string beans, around Kirkwood, and in Europe it is recorded by M. Ch. Goureau* as not only infesting the ears of Indian corn, but as devouring the heads of hemp, and leaves of tobacco, and of lucern. The fact of its attacking a kind of pea, namely, the chick-pea or coffee-pea (*Cicer arietinum*) has also been recorded by M. J. Fallou (See *Insectologie Agricole*, 1869, p. 205) in certain parts of France, the young worms feeding on the leaves but the larger individuals boring through the pods and devouring the peas.

[Fig. 42.]



Thus it seems to be almost as promiscuous in its tastes as the Stalk-borer (*Gortyna nitela*, Guen.), which burrows in the stalks of the Potato, of the Tomato, of the Dahlia, of the Aster and other garden flowers, of the common Cocklebur and of Indian corn, besides boring into green corn-cobs and eating into green tomatoes and ripe strawberries, and in a single instance in Missouri eating into peach twigs, and in Illinois inhabiting the twigs of the Black Currant.†

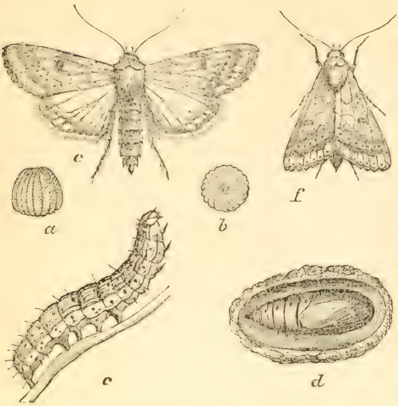
But for the present we will consider this insect only in the two roles of Boll-worm and Corn-worm, because it is as such that it interests the practical man most deeply.

The egg from which the worm hatches (Fig. 43, *a* side view; *b*, top view magnified) is ribbed in a somewhat similar manner to that of the Cotton-worm, figured in my Second Report (p. 38) but may readily be distinguished by being less flattened, and of a pale straw color instead of green. It is usually deposited singly on the outside

* *Insectes Nuisibles*, 2nd supplement, 1865, p. 132.

† See *Am. Ent.* I. p. 206; II. p. 13.

[Fig. 43.]



of the involucel or outer calyx of the flower or young boll, and each female moth is capable of thus consigning to their proper places, upwards of five hundred eggs. Mr. Glover, in his account of the Boll-worm, published in the Monthly Report of the Department of Agriculture for July, 1866, says: "Some eggs of the Boll-worm moth hatched in three or four days after being brought in from the field, the enclosed worms gnawing a hole through the shell of the egg and then escaping. They soon commenced feeding upon the tender fleshy substance of the calyx, near the place where the egg had been deposited. When they had gained strength, some of the worms pierced through the calyx, and others through the petals of the closed flower-bud, or even penetrated into the young and tender boll itself. The pistils and stamens of the open flower, are frequently found to be distorted and injured without any apparent cause. This has been done by the young Boll-worm; when hidden in the unopened bud, it has eaten one side only of the pistils and stamens, so that when the flower is open the parts injured are distorted and maimed, and very frequently the flower falls without forming any boll whatever. In many cases, however, the young worm bores through the bottom of the flower into the immature boll before the old flower falls, thus leaving the boll and involucel or envelope still adhering to the foot-stalk, with the worm safely lodged in the growing boll. The number of buds destroyed by this worm is very great, as they fall off when quite small, and are scarcely observed as they lie brown and withering on the ground beneath the plant. The instinct of the Boll-worm, however, teaches it to forsake a bud or boll about to fall, and either to seek another healthy boll, or to fasten itself to a leaf, on which it remains until at length it acquires size and strength sufficient to enable it to bore into the nearly matured bolls, the interior of which is nearly destroyed by its attacks, as, should it not be completely devoured, rain penetrates through the hole made by the worm, and the cotton soon becomes rotten and will not ripen. * * * * * * * *
One thing is worthy of observation, and that is, whenever a young boll or bud is seen with the involucre spread open, and of a sickly yellow color, it may be safely concluded that it has been attacked by the Boll-worm, and will soon perish and fall to the ground. * * *

The buds injured by the worm may be readily distinguished by a minute hole where it has entered, and which, when cut open, will be found partially filled with small black grains, something like coarse gun powder, which is nothing but the digested food after having passed through the body of the worm."

This insect is very variable in the larva state, the young worms varying in color from pale green to dark brown. When full grown there is more uniformity in this respect, though the difference is often sufficiently great to cause them to look like distinct insects. Yet the same pattern is observable, no matter what may be the general color; the body being marked as in the above figures with longitudinal light and dark lines, and covered with black spots which give rise to soft hairs. Those worms which Mrs. Treat found in green peas and upon corn tassels had these lines and dots so obscurely represented that they seemed to be of a uniform green or brown color, and the specimens which I saw last summer in string beans were also of a dark glass green color with the spots inconspicuous, but with the stripe below the breathing pores quite conspicuous and yellow. The head, however, remains quite constant and characteristic. Figure 42 may be taken as a specimen of the light variety, and Figure 43, *c*, as illustrating the dark variety. When full grown, the worm descends into the ground, and there forms an oval cocoon of earth interwoven with silk, wherein it changes to a bright chestnut-brown chrysalis (Fig. 43, *d*), with four thorns at the extremity of its body, the two middle ones being stouter than the others. After remaining in the chrysalis state from three to four weeks, the moth makes it escape. In this last and perfect stage, the insect is also quite variable in depth of shading, but the more common color of the front wings is pale clay-yellow, with a faint greenish tint, and they are marked and varigated with pale olive and rufous, as in Figure 43, (*e* showing the wings expanded, and *f* representing them closed), a dark spot near the middle of each wing being very conspicuous. The hind wings are paler than the front wings, and invariably have along the outer margin a dark brown band, interrupted about the middle by a large pale spot.

Mr. Glover says that there are at least three broods each year in Georgia, the last brood issuing as moths as late as November. With us there are usually but two, though, as already hinted, there may be exceptionally three. Most of the moths issue in the fall, and hibernate as such, but some of them pass the winter in the chrysalis state and do not issue till the following spring. I have known them to issue, in this latitude, after the 1st of November, when no frost had previously occurred.

In 1860—the year of the great drought in Kansas—the corn crop in that State was almost entirely ruined by the Corn-worm. According to the *Prairie Farmer*, of January 31, 1861, one county there which raised 436,000 bushels of corn in 1859, only produced 5,000 bushels of poor wormy stuff in 1860; and this, we are told, was a fair sample of most of the counties in Kansas. The damage done was not by any means confined to the grain actually eaten by the worm; but "the ends of the ears of corn, when partially devoured and left by this worm, afforded a secure retreat for hundreds of small insects, which, under cover of the husk, finished the work of destruction commenced by the worm eating holes in the grain or loosening them from the cob. A species of greenish-brown mould or fungus grew likewise in such situations, it appearing that the dampness from the exuded sap favored such a growth. Thus decay and destruction rapidly progressed, hidden by the husk from the eye of the unsuspecting farmer." It appears also that many horses in Kansas subsequently died from disease, occasioned by having this half-rotten wormy corn fed out to them.

Remedies.—It is the general experience that this worm does more injury to very early and very late corn than to that which ripens intermediately, for though the broods connect by late individuals of the first and early individuals of the second, there is nevertheless a period about the time the bulk of our corn is ripening, when the worms are quite scarce. I have never yet observed their work on the green tassel, as it has been observed in New Jersey, and do not believe that they do so work with us. Consequently it would avail nothing as a preventive measure, to break off and destroy the tassel, and the only remedy when they infest corn is to kill them by hand. By going over a field when the ears are in silk, the presence of the worms can be detected by the silk being prematurely dry or by its being partially eaten.

In the South various plans have been adopted to head off the Boll-worm, but I believe none have proved very successful. The following experiment with vinegar and molasses, was made by B. A. Sorsby, of Columbus, Ga., as quoted by Mr. Glover:

"We procured eighteen common-sized dinner plates, into each of which we put half a gill of vinegar and molasses, previously prepared in the proportion of four parts of the former to one of the latter. These plates were set on small stakes or poles driven into the ground into the cotton field, one to about each three acres. and reaching a little above the cotton plant, with a six-inch square board tacked on the top to receive the plate. These arrangements were made in the evening, soon after the flies had made their appearance; the next morning we found eighteen to thirty-five moths to each plate. The experiment was continued for five or six days, distributing the plates over the entire field; each day's success increasing until the numbers were reduced to two or three moths to each plate, when it was abandoned as being no longer worthy of the trouble. The crop that year was but very little injured by the Boll-worm. The flies were caught in their eagerness to feed upon the mixture by alighting into it and being unable to escape. They were probably attracted by the odor of the preparation, the vinegar probably being an important agent in the matter. As the flies feed only at night, the plates should be visited late every evening, the insects taken out, and the vessels replenished as circumstances may require. I have tried the experiment with results equally satisfactory, and shall continue it until a better one is adopted."

Mr. J. M. Heard, of Monroe county, Wisconsin, patented in 1860, a device for trapping the moth, which consists of a tin plate placed on a funnel, which is connected with a bait-pan made of the same material, and which is to be partially filled with molasses mixed with a little anise, fennel or other essential oil. From one summer's test of the trap, I do not think much of it as a decoy for the moth, and it would be altogether too expensive, when the great number required to properly protect a large cotton field is taken into consideration.

THE FALL ARMY-WORM—*Prodenia autumnalis*, Riley.

[Lepidoptera, Noctuidæ.]

In 1868 the true Army-worm appeared in certain portions of the State and I gave a full account of it in my second Report. Last fall another worm very generally mistaken for that insect made its appearance very generally over the State, and caused considerable alarm. Specimens were sent to me from Moniteau, Jefferson, Pulaski and Cole counties, while it was common throughout the greater portion of the county of St. Louis.

The first notice I received of it was from the following item which appeared in the *Journal of Agriculture* of St. Louis:

ARMY WORM.—*Editors Journal Agriculture:* Since Friday (26th August), the Army-worm has made its appearance in distressingly large numbers almost everywhere in this (Cole) county. They have destroyed for me more than an acre of turnips, a good deal of my late soiling corn, and are still on the march for more. Farther in the country they have eaten up the buckwheat, which is just coming into bloom. Could our esteemed friend RILEY give us an article in the next *Journal?—F. A. Nitchy.*

JEFFERSON CITY, Mo., August 29th, 1870.

The following published paragraphs, which all refer to this same worm, and which chanced to meet my eye, will give some idea of the extent of country through which it ranged.

FALL ARMY-WORM.—We have received specimens of the Fall Army worm from several persons. The complaints of its ravages are quite numerous almost all over the State; they are very bad in northeast Missouri. Threatening at Tipton, from which place we have samples, and in St. Louis and Jefferson counties they are quite bad. This pest only returns at intervals, perhaps on account of parasitic and other enemies gaining the ascendancy over them.—*Rural World*, *Sept. 2nd*, 1870.

ARMY-WORM IN CALLAWAY COUNTY.—I have found that the Army-worm has been more or less on almost every farm, and have been examining some of the meadows over which they have passed, and have come to the conclusion they are about ruined. From my examination I think that nineteen-twentieths of the grass is entirely killed; at least there is not more than one bulb in twenty that shows any signs of vitality. Why should this insect make its appearance at this season? Mr. Riley, I believe claims that it makes its advent in the spring. But now we have it appearing at the end of summer and beginning of fall, and in numbers as great and as destructive as ever it did in spring. Could it be that the extreme heat of this season, with favorable conditions of moisture, has brought them forth prematurely? I noticed that some plum trees, cherry trees, smoke trees, summer roses and strawberries are blossoming freely from premature development.—*H. B.*, *Journal of Agriculture*, *Oct. 13th*, 1870.

The Army-worm, on the 28th of August, appeared in force in my neighbor's wheat stubble, moving south towards a piece of land that I had planted in corn, and then sown in rye that was up nicely. When they reached the fence (which they did on the 28th of August), I scattered salt thickly on the rich blue grass on my side of the fence, all along it, while the dew was on. They came no further. As I was obliged to be away from home, I cannot say whether the salt checked them or not—at any rate, it caused the grass to wilt and die.

A very small dark worm about half an inch long, has been doing some damage to the young grain of late.—*J. L. Erwin*, *Fulton, Callaway County*, *Mo.*

THE ARMY-WORM—A SLANDER ON THE BIRDS—*Editor Farmer*: Feeling it a duty, as well as a privilege, to contribute all good, or even really bad news for the farmers, through your truly valuable and very much improved and highly esteemed Farmers' journal, enclosed (in a small phial) please find some specimens of Army-worm. many millions of which infest our county. They are everywhere. It is said they are brought by a small, yellow bird, which goes in covies of twenty-five to two hundred—that wherever they alight, the worms first appear. It is said that each petaled portion of the feathers is covered with nits, and their number is legion.

We would be pleased to hear from some of our scientific men on the subject, as we are very much interested. They take a twenty-acre wheat field in two days.

These pestiferous little pests are rapidly arriving at maturity. In traveling, their course seems westward. They last appeared here in 1865, but too late in the season to do any great damage, as a cold rain sent them the way of all the earth. That being in October, nothing of the kind can be expected at this time; and if they are to remain here until October, woe to our wheat fields in this vicinity!

MINERAL POINT, Kansas, Aug. 29th, 1870.

[The above letter came to us too late for insertion last month. Our friends are doing great injustice to our little harmless "Prairie-birds," in supposing that they have anything to do with bringing the Army-worm—EDITOR].—*Kansas Farmer*, *October*, 1870.

ARMY WORM.—Late rains are keeping corn too green. Too muddy to plow for wheat. The Hessian-fly and Army-worm are too numerous to allow farmers to seed much this fall. The early sown wheat and much of the meadows are eaten up by the Army-worm. Dr. C W. Thornton, of Warrensburg, Kansas, in *Kansas Farmer*.

ARMY-WORM.—We have received from S. S. Tipton, of Mineral Point, a specimen of the above genius, but a little the worst demoralized specimen we ever saw. The bottle was broken, and, as well as we can determine, by the aid of a powerful magnifying glass, the worm is in about sixty thousand pieces. We shall refer to the subject in our next; but in the mean time, we advise our friends to plow and scrape out ditches, in which to spread dry straw. Then muster your force armed with brushes, drive them into the ditches, and set fire to the straw. We have seen them very successfully treated in this way. *Kansas Farmer*.

Thus in all the above accounts this worm was supposed to be a fall brood of the true Army-worm, and in the following letter, we shall see that it was also mistaken for the Corn-worm treated in the last article—a mistake not at all surprising considering the close resemblance between the two worms,

C. V. Riley, *Dear Sir*.—I herewith send you a box of what I believe to be the Boll-worm although its actions here were similar to the true Army-worm. At my father's and in the neighborhood they complain too of *the Army-worm* eating up the young oats and timothy. With me they commenced about two weeks ago in a field of young oats, or rather oat stubble which had been plowed under and sown to buck-wheat. The oats had got to be about six inches high and were eaten first, next the worm took what little crab grass they could find and they are now scattered, eating grass, corn silks, soft corn, rutabaga leaves and whatever in the grass line comes before them. They have not entered my meadow yet, nor a piece of wheat stubble which is plowed under. G. PAULS.

Eureka, Mo., Sep., 7, 1870.

On the farm of Jno. J. Squires at DeSoto, this worm at first ate off all the grass, then completely stripped the leaves from some corn-fodder, injured his corn, ate into his tomatoes and ruined his turnips —injuring his crops to the amount of nearly $1,000.

In some cases the worm acted strangely, and I have know it to take a whole field of rye in preference to wheat. Judge Wielandy, of Cole county informs me that it was abundant on his potatoes, cutting off the lateral stems. It invaded a large cucumber field and entirely cleaned out the crab grass, and would have injured his cucumbers had he not applied slacked lime. In some parts of Jefferson county it was very abundant and destructive, and Senator J. H. Morse, of Morse's Mills had twenty acres badly injured by it. I have also been informed that in some vineyards it did great damage by gnawing around the stems and causing the bunches to drop off and fall to pieces so that the grapes would scatter on the ground. But I cannot vouch for the correctness of the observation. With me it did more injury to corn than to anything else. It not only greedily devours the leaves and stems, but bores large holes through the ears, burrowing in them in all directions. On late corn it is frequently found in the same ear with the Corn-worm, *alias* Cotton Boll worm. The Boll-worm is, however, rougher, generally paler, striped differently (see Figs. 42 and 43, *c*.), and always readily distinguished by having a larger gamboge-yellow or reddish head, which invariably lacks the distinct white inverted Y-shaped mark, and the darker shadings of the head of the Fall Army-worm.

Now, until the present year nothing was absolutely known of the natural history of this worm, and though I knew that it was not the true Army-worm, and suspected, from comparing it with the description of certain corn-feeding worms received in 1868 from Mr. E. Daggy, of Tuscola, Illinois, that it would produce a certain moth which I bred from Mr. Daggy's worms—yet I could not feel positive without breeding the Fall Army-worm to the perfect state. This I very luckily did, and I am therefore able to give its complete history.

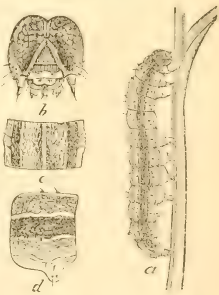
In the fall of 1868 I received a few specimens from Mr. T. R. Allen, of Allenton, with an account of their injuring newly sown wheat on oat stubble, and on page 88 of my first Report it was briefly described by the name of Wheat Cut-worm. The popular term of "Fall Army-worm" is, however, altogether more indicative than that of "Wheat Cut-worm," since the species does not confine its attacks to wheat, and not only very closely resembles the Army-worm in appearance but has many habits in common.

HOW IT DIFFERS FROM THE TRUE ARMY-WORM.

The two insects need never be confounded, however. The true Army-worm never appears in the fall of the year, but always about the time when wheat is getting beyond the milk state; and it generally disappears, in the latitude of St. Louis, by the first of June. It confines its attacks entirely to the grasses and cereals, whereas the species under consideration is a much more general feeder, devouring with equal relish most succulent plants, such as wheat, oats, corn, barley, grasses, purslane, turnips, and, as Mr. J. M. Jordan of St. Louis informs me, even spruces. Moreover, when critically examined, the two worms show many characteristic differences, as will be seen by comparing Figure 44, which represents the true Army-worm, with Figure 45, which represents at *a* the Fall Army-worm natural size, at *b* its head magnified, at *c* a magnified dorsal view of one of the joints, and at *d* a magnified side view of same.

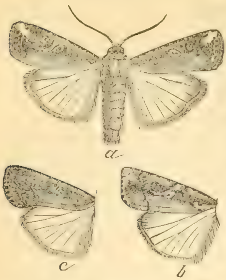
[Fig. 44.]

[Fig. 45.]



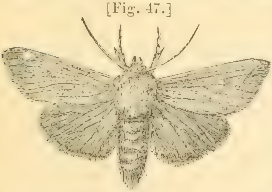
Our Fall Army-worm moth is a most variable one—so variable, indeed, that at least three species might easily be fabricated by any species-grinder who happened to capture at large the three most distinct varieties, without knowing anything of their transformations. I have bred 31 specimens, all from larvæ found on corn, and have others which were captured at large, and though half a dozen sufficiently distinct varieties might easily be picked out from among them, and though scarcely any two are precisely alike, yet they may all be divided into three distinct sets or varieties. The first of these, which is the more common, is represented at Figure 46, *a*, the second at *b*, and the third at *c*. For those who are more curious in such matters I append, at the end of this article, a more elaborate description of this new moth. Not only do I find this great variation in this particular species, but all the species of the genus to which it belongs are variable; and Guenée has truly remarked that they resemble each other so closely, and their modifications are so complicated, that it is next to impossible to properly separate them. By comparing the annexed Figures 46 *a*, *b* and *c*, with that of the true Army-worm moth (Fig. 47) the two insects will be found to differ widely.

[Fig. 46.]

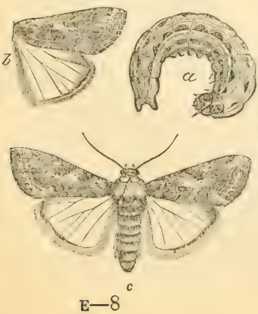


We have in this country a very common moth (*Prodenia commelinæ*, Abb.) which may be popularly called the Spiderwort Owlet moth, some of the varieties of which approach so nearly to some of the more strongly marked varieties of our Fall Army-worm moth that it is necessary to show the very great difference which really exists between them, in order that the cultivator may not be unnecessarily alarmed when he observes the former, by confounding it with the latter, and erroneously inferring that he will be overrun with Fall Army-worms when there is no real danger. The Spiderwort Owlet moth, (Fig. 48, *b* and *c*) is a handsomer and more distinctly marked species, the front wings inclining more to vinous-gray, or purplish-gray, and the ordinary lines being more clearly defined by very deep brown, than in the Fall Army-worm moth. But, however much these characters may vary—and they are quite variable—there are yet two others which will be readily noticed upon comparing the figures of the two species, and by which the Spiderwort moth may always

[Fig. 47.]



[Fig. 48.]



be distinguished from its close ally, namely, by the tip of the wing being more prolonged and acuminate, and by the three-forked nerve in the middle of the wing being much more conspicuous. Its larva never congregates in multitudes as does the Fall Army-worm, and differs so materially from that worm, and is withal so characteristically marked, that it may be recognized at once by the above illustration (Fig. 48, *a*). Contrary to what its name would indicate, it is a very general feeder, as I have found it on all sorts of succulent plants, both wild and cultivated, This insect is more or less numerous every year, but has never been known to multiply so prodigiously as the Fall Army-worm, which we have under consideration. It passes the winter either in the larva, pupa or perfect state, but more generally in the former.

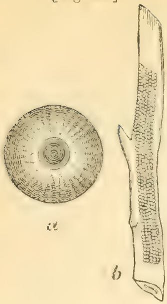
REMEDIES.

Now that I have sufficiently dwelt on the characteristics of the Fall Army-worm to enable any one to distinguish it, even from its nearest relative, let us consider for a moment what can be done to prevent its great injuries to grains and to vegetables. I have proved that there are at least two, and probably as many as three or even four broods during the course of the year; for those worms which appeared in such multitudes in August and the forepart of September, in due time produced moths, and these gave birth to a new generation of worms, which began to make their presence manifest towards the end of October. In 1868, also, I bred the moth as early as July, from worms received from Mr. Daggy. In this prolificacy the Fall Army-worm differs remarkably from the true Army-worm, as well as from most of its close allies, which generally produce but one, and seldom more than two, broods each year.

The moths were so numerous during the latter part of September and the forepart of October, that I not only found them common at Decatur, Vandalia and other parts of Central Illinois, and wherever I traveled in our own State, but I captured a goodly number in the very heart of St. Louis, and even caught some while riding by rail.

The eggs are deposited in small clusters, often in two or three layers one above the other, and the whole cluster is covered sparsely with the yellowish hairs from the ♀ abdomen. Each egg is nearly spherical, of a pale fulvous color, and differs only from that of the Unarmed Rustic (*Agrotis inermis,* Fig. 49, *a*, showing one magnified, and *b*, a batch of natural size,) in being less compressed and less distinctly ribbed. The clusters were found abundantly, not only on the under side of peach and apple leaves, which the worms readily devour, but on the leaves of such trees as sycamore, which, so far as we at present know, they do not feed upon. Under these last circumstances the young worms, upon hatching, would soon descend the tree to feed upon the more succulent herbage below; and the more I learn of the habits of our different Owlet moths,

[Fig. 49.]



the more I become convinced that the long-accepted theory of their eggs being deposited on the ground is a false one, and that most of our cut-worms though fat, lazy and groveling in the ground when we find them, have been born in more elevated and exalted positions.

In the fall of 1868 this worm proved very destructive to the newly sown wheat in many parts of Franklin and St. Louis counties, Mo., and seemed to be confined to such wheat as was sown on oats stubble. I then accounted for this singular state of things by supposing that the scattering oats which were left after harvest had sprouted before the wheat, and had thus attracted the parent moths*; and, acting upon this supposition, I suggested that the attacks of the worm might effectually be prevented by plowing the land early and keeping the ground clear of all vegetation until the wheat was planted. This inference proves to be well warranted by the facts; and in future, when the Fall Army-worm is heard of during the months of August or September, as it was the present year, it will be wise for those who live in the immediate neighborhood, either to sow no fall grain at all or to endeavor, in doing so, to carry out the above suggestions. The last brood of worms, which at this writing (Nov. 7th) are not yet quite full grown, must evidently pass the winter in the ground, either in the larva or the pupa state. In either case a great many of them would be killed by late fall plowing which should be used, when practicable, as a remedial measure in fields where this insect has been numerous. When the worms are overrunning a field of fall grain, most of them could be destroyed by means of a heavy roller, without injury to the grain.

The question has been repeatedly asked: "Will this worm be as numerous next year as it has been this; or will it go on increasing in geometrical ratio, and be still more numerous?" Now, although I greatly dislike to weaken the confidence that some people seem to place in the oracular power of an entomologist to peer into the future, yet I must meekly confess my inability to give any definite answer to such questions.

Byron has truly said that, "the best of prophets of the future is the past;" and we may reasonably draw the inference that this worm will *not* be so abundant next year, because in the past it has only occasionally been so troublesome, and never, so far as the record shows, during two consecutive years. And we may rest tolerably well assured that it will not increase in geometrical ratio, because most vegetable feeding insects are preyed upon by more predaceous

*Report I, p. 88.

species and by parasites,* and because such continued increase of one species is inconsistent with the harmony we find everywhere in Nature. But we may not venture beyond the inference, as the happenings of the future are not for mortals to know. Some persons may also be curious to learn why this worm increases so much more in late summer and fall than in spring, since there are so many broods during the year; or why it is only noticed in certain years? Such questions, likewise, can receive no definite answer,

> "Till old experience do attain
> To something like prophetic strain."

For though, to meet the first, we may assume that the winter decimates their numbers, or that the spring weather is not favorable to their increase; and to meet the last we may conjure up a hundred reasons yet assuming is not knowing, and we must content ourselves with the facts as they occur.

In conclusion, it will afford a grain of comfort to those who have had wheat fields cleaned off by this worm, to know that their wheat is not necessarily ruined; for, as I personally ascertained, wheat that had been thus cut off in the fall of 1868 made a good stand the following spring; and in one instance, where part of a field had been invaded and the rest left untouched, it really appeared that the part which had been eaten off yielded the heaviest. Mr. Huron Burt, of Callaway county, Mo., also informs me that this insect always leaves blue-grass untouched.

PRODENIA AUTUMNALIS, Riley.—*Imago* (Fig. 46, *a, b* and *c*.)—*Front wings* narrow with the apex usually well rounded, and with the middle of the hind margin sometimes, but not often, extending beyond apex: general color mouse-gray variegated with smoky-brown, fulvous and pearly or bluish-white; apical patch bluish-white and never extending beyond nerve 5: the subterminal line—which is pale and bends like a bow, approaching nearest the terminal line between nerves 3 and 4—generally blends with this patch so as to appear to start from its lower edge, but is sometimes well separated from it so as to be traced further towards apex: dark space preceding subterminal line, confined between nerves 3 and 5, blending gradually with the rest of the wing, barely showing two darker sagittate spots: transverse anterior and transverse posterior either subobsolete or tolerably well defined, each by a geminate dark line: basal area divided longitudinally by an irregular dark line, the wing below it quite light-colored: orbicular spot large and elongated, a little lighter than surrounding surface, and well defined by a fulvous annulation, the pale oblique shade which generally encloses it in this genus confined to a fulvous shade above, and either a more distinct fulvous line behind or none at all: reniform spot generally dark, but sometimes lighter than space preceding; not well defined, the small pale spot at top being generally distinct, and either partaking of the same form, or resembling the small letter *c* [left wing]; the lower edge occupied by a distinct white dash, which however never extends beyond it and but seldom shows any tendency to furcate with the nerves: four tolerably distinct equidistant pale costal spots from reniform spot to apical patch: terminal line pale, even, parallel with posterior margin: terminal space dark, except near apex and anal angle, divided into subquadrate spots by the pale nerves: fringe either broad or narrow, of same color as wing, with a narrow darker inner line, relieved by two very fine paler ones which are barely distinguishable: under surface smoky, but paler inte-

* Many of the Fall Army-worms had the thoracic joints of the body more or less covered with the eggs of a *Tachina* fly, and I have bred from the worms the same parasite (*Exorista leucaniæ*, Kirk; 2d Rep. Fig. 17) which infests the true Army-worm, and still another allied species (*Tachina archippivora*) which infests the larvæ of the Archippus butterfly, and will be referred to on a future page.

riorly and terminally, and fulvous along costa; the whole with a nacreous lustre and more or less irrorate with brown, and often with a flesh-colored tint near apex; fringes dark. *Hind wings* white with a faint fulvous tint; semi-transparent and slightly irridescent, with extremities of nerves and borders, especially above, brown; fringes dusky, especially at apex, and with a paler inner line; under surface similar. Thorax, abdomen and legs of same general color as front wings, being paler below; the longer lateral and anal abdominal hairs more fulvous. Sexes with difficulty distinguished, the size and shape of the abdomen not even being a safe criterion. Maximum expanse 1.40; minimum expanse 1.05 inches. Described from 18 specimens, bred Sept. 20th—Oct. 10th, from corn-fed larvæ.

VARIETY FULVOSA, (Fig. 46, *b.*)—*Front wings* greatly suffused with fulvous, especially in the lower median space, which often inclines to ochraceous; apical space more or less defined; oblique median band distinct to median nerve, and orbicular spot with an ochre-colored centre. Described from 5 specimens, bred Sept. 25th—Oct. 3rd, from corn-fed larvæ.

VARIETY OBSCURA, (Fig. 46, *c.*)—*Front wings* of a much more uniform and darker color, either grayish-brown with a slight vinous tint, or deep smoky brown inclining to black, or a deep warm brown with but little gray; apical space either entirely obsolete or but very faintly indicated; oblique fulvous band across upper middle of wing also obsolete; the ordinary lines either entirely obsolete [one specimen only] or distinctly marked; the ordinary spots sometimes obsolete, but more generally indicated by fulvous lines. Described from 8 specimens, bred Sept. 21st—Oct. 2d, from corn-fed larvæ.

Larva, (Fig. 45, *a.*)—Ground-color very variable, generally dark and pitchy-black when young, but varying after the last moult from pale brown to pale dirty green, with more or less pink or yellow admixed—all the markings produced by fine, more or less intense, brown, crimson and yellow mottlings. Dorsum brownish with a narrow line down the middle, rendered conspicuous by a darker shade each side of it. A dark, subdorsal band one-third as wide as each joint is long; darkest at its upper edge, where it is bordered and distinctly separated from dorsum by a yellow line which, except on joint 11 where it deflects a little upwards, is quite straight; paler in the middle of each joint. A pale, either buff or flesh-colored, substigmatal band, bordered above and below by a narrow, yellow and wavy line. Venter pale. Head pale yellowish-brown, with sometimes a tinge of green or pink; the triangular piece yellowish, the Y-mark distinct and white, the cheeks with four more or less distinct lateral brown lines and with dark brown mottlings and nettings, which become confluent and form a dark curved mark at the submargin behind the prongs and each side of the stem of the Y. Stigmata large, brown, with a pale annulation, and just within the lower edge of the dark subdorsal band. Legs either light or dark. Cervical shield darker than body, with the narrow dorsal and subdorsal lines extending conspicuously through it: anal plate also dark, narrow and margined by the pale subdorsal lines—both plates furnishing stiff hairs, but without tubercles. Piliferous tubercles on joints 2 and 3, arranged in a transverse row, and quite large, especially on joint 2; on joints 4–10 inclusive the superior eight are arranged as follows: 4 in a trapezoid in dorsal space, the posterior two as far again from each other as the anterior two, and two near stigmata, one above and one behind; on joint 11 the dorsal 4 are in a square, and on joint 12 in a trapezoid, with the posterior and not the anterior ones nearest together: the thoracic joints have each a large subventral tubercle just above the legs. Length 1.10–1.50 inch. Described from numerons specimens.

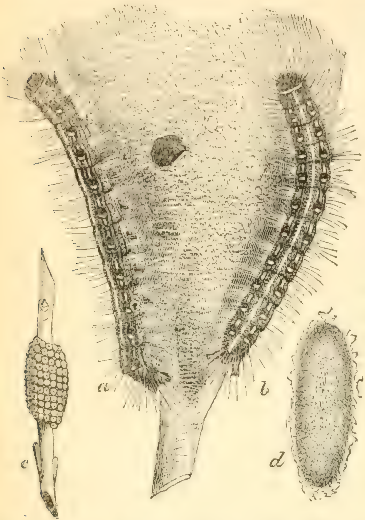
Pupa.—Formed in the ground, without cocoon; of normal form, bright mahogany-brown, and with a distinct forked point at extremity.

THE APPLE-TREE TENT-CATERPILLAR, OR AMERICAN LACKEY MOTH.—*Clisiocampa Americana,* Harr.

(Lepidoptera, Bombycidæ.)

What orchardist in the older States of the Union is not familiar with the white web-nests of this caterpillar? As they glisten in the rays of the spring sun, before the trees have put on their full summer dress, these nests, which are then small, speak volumes of the negligence and slovenliness of the owner of the orchard, and tell more truly than almost anything else why it is that he fails and has bad luck with his apple crop. Wherever these nests abound one feels morally certain that the borers, the Codling-moth, and the many other enemies of the good old apple tree, mentioned in the beginning of this Report, have full play to do as they please, unmolested and unnoticed by him whom they are ruining; and when I pass through an orchard with two, three or more "tents" on every tree, I never pity the owner, because there is no insect more easily kept in check.

[Fig. 50.]



The small, bright and glistening web, if unmolested, is soon enlarged until it spreads over whole branches, and the caterpillars which were the architects, in time become moths, and lay their eggs for an increased supply of nests another year.

This insect is so well known throughout the country, and has been so well treated of by Harris and Fitch, that it is only necessary to give here the most prominent and important points in its history, the more especially as the figures alone which are given herewith will enable the novice to recognize it the moment it appears in a young orchard. Though some years quite abundant, it is not as common with us as in some of the Eastern States.

The eggs (Fig. 50, *c*) from which these caterpillars hatch are deposited mostly during the month of June, in oval rings, upon the smaller twigs, and this peculiar mode of deposition renders them conspicuous objects during the winter time, when by a little practice they can easily be distinguished from the buds, knots or swellings of the naked twigs. Each cluster consists of from two to three hundred eggs, and is covered and protected from the weather by a coating of glutinous matter, which dries into a sort of net-work. The little embryonic larvæ are fully formed in the egg by the commencement of winter, and the same temperature which causes the apple-buds to swell and burst, quickens the vital energies of these larvæ and causes them to eat their way out of their eggs. Very often they hatch during a prematurely warm spell and before there is any green leaf for them to feed upon, but they are so tough and hardy that they can fast for many days with impunity, and the glutinous substance on the outside of their eggs furnishes good sustenance and gives them strength at first. It is even asserted by Mr. H. C. Raymond, of Council Bluffs, Iowa, that the eggs often hatch in the fall and that in these cases the larvæ withstand the severity of the winter with impunity.

The young caterpillars commence spinning the moment they are born, and indeed they never move without extending their thread wherever they go. All the individuals hatched from the same batch of eggs work together in harmony, and each performs its share of building the common tent, under which they shelter when not feeding and during inclement weather. They usually feed twice each day, namely, once in the forenoon and once in the afternoon. After feeding for five or six weeks, during which time they change their skins four times, these caterpillars acquire their full growth, when they appear as at Figure 50 (*a* side view, *b* back view) the colors being black, white, blue and rufous or reddish. They then scatter in all directions in search of some cozy and sheltered nook, such as the crevice or angle of a fence, and having finally decided on the spot, each one spins an oblong-oval yellow cocoon (Fig. 50, *d*) the silk composing which is intermixed with a yellow fluid or paste, which dries into a powder looking something like sulphur. A few individuals almost always remain and spin up in the tent, and these cocoons will be found intermixed with the black excrement long after the old tent is deserted.

[Fig, 51.]

Within this cocoon the caterpillar soon assumes the chrysalis state, and from it, at the end of about three weeks, the perfect insect issues as a dull yellowish-brown or reddish-brown moth (Fig. 51), characterized chiefly by the front wings being divided into three nearly equal parts by two transverse whitish, or pale yellowish lines, and by the middle space between these lines being paler than in the rest of the wing in the males, though it is more often of the same color, or even darker in the females. The species is, however, very variable.*

The moths do not feed, and the sole aim of their lives seems to be the perpetuation of their kind; for as soon as they have paired and each female has carefully consigned her eggs to some twig, they die,

* Dr. Fitch, in the very excellent and detailed account of this insect in his second Report, shows how very variable the moth is, and from a large series of bred and captured specimens, I can fully corroborate the fact. I have specimens which are of an almost uniform pale tawny-yellow, while others are very dark, being what might be termed a bay-brown with the pale markings conspicuous, while others have a pale band across the hind wings so conspicuous as to very closely resemble the European *neustria*. Dr. Fitch in referring to his figures must certainly have made a mistake, for he calls Figure 4 the female and Figure 3 the male, while the reverse is apparent from the figures themselves. My own figure is intended to represent the female, but the middle space of the upper wings seldom if ever appears so light in this sex, as the engraver has erroneously represented.

and when the proper time comes around again the eggs will hatch, and the same cycle of changes takes place each year.

This insect in all probability extends wherever the wild black cherry (*Cerasus serotina*) is found, as it prefers this tree to all others; and this is probably the reason why the young so often hatch out before the apple buds burst, because, as is well known, the cherry leafs out much earlier. Besides the Cherry and Apple, both wild and cultivated, the Apple-tree Tent-caterpillar will feed upon Plum, Thorn, Rose and perhaps on most plants belonging to the Rose family, though the Peach is not congenial to it, and it never attacks the Pear, upon which, according to Dr. Trimble, it will starve. It does well on Willow and Poplar and even on White Oak, according to Fitch, who also found it on Witch Hazel (*Hamamelis*) and Beech.

REMEDIES.

Cut off and burn the egg-clusters during winter, and examine the trees carefully in the spring for the nests from such clusters that may have eluded the winter search. The eggs are best cut off in the manner presently to be described for the Tent-caterpillar of the Forest. Though to kill the caterpillars numerous methods have been resorted to, such as burning, and swabbing with oil, soap-suds, lye, etc., they are all unnecessary, for the nests should not be allowed to get large, and if taken when small are most easily and effectually destroyed by going over the orchard with the fruit-ladder, and by the use of gloved hands. As the caterpillars feed about twice each day, once in the forenoon and once in the afternoon, and as they are almost always in their nests till after 9 A. M., and late in the evening, the early and late hours of the day are the best in which to perform the operation. As a means of facilitating this operation, it would be a good plan, as Dr. Fitch has suggested, to plant a few wild cherry trees in the vicinity of the orchard, and as the moths will mostly be attracted to such trees to deposit their eggs, and as a hundred clusters on a single tree are destroyed more easily than if they were scattered over a hundred trees, these trees will well repay the trouble wherever the Tent-caterpillar is known to be a grievous pest.

The chrysalids of this caterpillar are often found filled with little maggots, which produce minute Chalcididan 4-winged flies of metallic green and black colors,* and belonging to the very same genus as the celebrated Hessian-fly parasite. This parasite, with other cannibal insects, and perhaps more or less favorable seasons, tend to produce a fluctuation in the numbers of these caterpillars, so that they are more numerous some years than others, and they were more numerous in 1868 than they have been since. It has also been noticed that dry summers are injurious to them. According to Dr. LeBaron,

* Described as *Cleonymus clisiocampæ* by Dr. Fitch (Rep., vol. I, p. 200), but subsequently more properly referred to the genus *Semiotellus* (Rep., Vol. III, p. 141.

the Baltimore Oriole occasionally pecks at the nests, but does not make a common article of diet of the caterpillars, and the only birds that devour them greedily are the American Cuckoos (*Coccyzus Americanus* and *erythrophthalmus*).

THE TENT-CATERPILLAR OF THE FOREST—*Clisiocampa sylvatica*, Harr.

(Lepidoptera, Bombycidæ.)

There is another insect which in all its stages so closely resembles the Apple-tree Tent-caterpillar as to be very generally confounded with it. This insect was first described by the great Massachusetts entomologist, Dr. Harris, and very appropriately named the Tent-Caterpillar of the Forest, the better to distinguish it from the other species which is more common in our orchards. He, however, unqualifiedly states that it lives in communities under a common web or tent; but with this exception gives a very clear and truthful account of it.* It has been quite destructive in many parts of Missouri during the past two summers, and as I have had good opportunities of studying its habits I shall endeavor to dispel the confusion and uncertainty about them which have hitherto existed in the minds of most of our farmers.

ITS NATURAL HISTORY.

The egg-mass from which the Tent-caterpillar of the Forest hatches (Fig. 52, *a*, showing it after the young larvæ have escaped) may at once be distinguished from that of the common Tent-caterpillar by its being of a uniform diameter, and docked off squarely at each end. It is usually composed of about 400 eggs, the number in five masses which I counted ranging from 380 to 416. Each of the eggs composing this mass is of a cream-white color, 0.04 inch long and 0.025 inch wide, narrow and rounded at the attached end or base, gradually enlarging towards the top, where it becomes slightly smaller (Fig. 52 *d*), and abruptly terminates with a prominent circular rim on the outside, and a sunken spot in the centre (*c*). These eggs are deposited in circles, the female moth stationing herself, for this purpose, in a transverse position across the twig. With abdomen curved she gradually moves as the deposition goes on, and when one circle is com-

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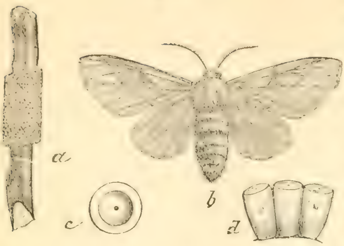
* Inj. Ins. p. 376.

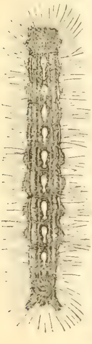
[Fig. 52.]



pleted, she commences another—and not before. With each egg is secreted a brown varnish which firmly fastens it to the twig and to its neighbor, and which, upon becoming dry, forms a carinated net-work of brown over the pale egg-shell. These eggs are so regularly laid and so closely glued to each other, and the sides are often so appressed, that the moth economizes space almost as effectually as does the Honey-bee in the formation of its hexagonal cells. In confinement the moth very seldom succeeds in forming a perfect ring, but in her abortive attempts, deposits them in different sized patches; and as I have found such unfinished patches attached to an oak leaf out-of-doors, we may conclude that either from injury or debility of some kind, the parent's instinct sometimes fails it even when all the conditions are normal and natural.

The eggs are deposited, in the latitude of St. Louis, during the latter part of June. The embryo develops during the hot summer weather, and the yet unborn larva is fully formed by the time winter comes on. The young hatch with the first warm weather in spring—generally from the middle to the last of March—and though the buds of their food-plant may not have opened at the time, and though it may freeze severely afterwards, yet these little creatures are wonderfully hardy, and can fast for three whole weeks, if need be, and withstand any amount of inclement weather. The very moment these little larvæ are born, they commence spinning a web wherever they go. At this time they are black with pale hairs, and are always found either huddled together or traveling in file along the silken paths which they form when in search of food. In about

[Fig. 53.]



two weeks from the time they commence feeding they go through their first moult, having first grown paler or of a light yellowish brown, with the extremities rather darker than the middle of the body, with the little warts which give rise to the hairs quite distinct, and a conspicuous dark interrupted line each side of the back. After the first moult, they are characterized principally by two pale yellowish subdorsal lines, which border what was before, the dark line above described. After the second moult, which takes place in about a week from the first, the characteristic pale spots on the back appear, the upper pale line becomes yellow, the lower one white, and the space between them bluish: indeed, the characters of the mature larva are from this period apparent. Very soon they undergo a third moult, after which the colors all become more distinct and fresh the head and anal plate have a soft bluish velvety appearance, and the hairs seem more dense. After undergoing a fourth moult without material change in appearance, they acquire their full growth in about six weeks from the time of first feeding. At this time they appear as at Figure 53, and for those who are interested in such matters, I quote below Dr. Fitch's description of the full-grown larva, as it is the first accurate and detailed description that was published, and as I have occasion to refer to it further on:

"The caterpillar, as seen after it has forsaken its nest and is wandering about, is an inch and a half long and 0.20 thick. It is cylindrical and of a pale blue color, tinged low down on each side with greenish gray, and is everywhere sprinkled over with black points and dots. Along its back is a row of ten or eleven oval or diamond-shaped white spots which are similarly sprinkled with black points and dots, and are placed one on the fore part of each segment. Behind each of these spots, is a much smaller white spot, occupying the middle of each segment. The intervening space is black, which color also forms a border surrounding each of the spots, and on each side is an elevated black dot from which arises usually four long black hairs. The hind part of each segment is occupied by three crinkled and more or less interrupted pale orange-yellow lines, which are edged with black. And on each side is a continuous and somewhat broader stripe of the same yellow color, similarly edged on each of its sides with black. Lower down upon each side is a paler yellow or cream-colored stripe, the edges of which are more jagged and irregular than those of the one above it, and this stripe also is bordered with black, broadly and unevenly on its upper side and very narrowly on its lower side. The back is clothed with numerous fine fox-colored hairs, and low down on each side are numerous coarser whitish ones. On the under side is a large oval black spot on each segment except the anterior ones. The legs and prolegs are black and clothed with short whitish hairs. The head is of a dark bluish color freckled with numerous black dots and clothed with short blackish and fox-colored hairs. The second segment* or neck is edged anteriorly with cream white, which color is more broad upon the sides. The third and fourth segments have each a large black spot on each side. The instant it is immersed in spirits the blue color of this caterpillar vanishes and it becomes black.

At this stage of its growth the Tent-caterpillar of the Forest may be seen wandering singly over different trees, along roads, on the tops of fences, etc., in search of a suitable place to form its cocoon. It usually contents itself with folding a leaf or drawing several together

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* It is necessary to remark here that in the above description, Dr. Fitch reckons the head as the first segment and the first leg-bearing segment of the body, which he calls the neck, as the second segment. If Lepidopterists could be induced to adopt some uniform rule in describing larvæ, it would prevent much confusion and error.

It is astonishing how loosely these segments are referred to by most authors. Thus Dr. Fitch, after calling the head the first segment in the above description, excludes it in the descriptions of the larvæ of *Dryocampa senatoria and Dryocampa stigma* which immediately follow (Reports 3, 4 and 5, §§ 322 and 323), and speaks of the long anterior horns as proceeding from the *second* segment, whereas, to be consistent, he should have made them proceed from the *third* segment, as Mr. Wm. Saunders has done with *Dryocampa rubicunda* (*Can. Entomologist* II, p. 76). Dr. Packard (Guide etc, p. 271) speaks of the caudal horn of the larvæ of *Sphingidæ* as proceeding from the *last* segment, which it certainly does not, whichever custom be adopted. Westwood (Intr., II,) though his language on page 319 would lead one to suppose that he included the head as the first segment, more often adopts the other rule, as for instance when he refers to the 11th segment in *Mamestra*, etc., (p. 344). Burmeister in his Manual of Entomology evidently excluded the head as a segment, for he refers (p. 35) to the "three first segments of the body following the head," and afterwards (p. 41) speaks in more precise terms of the body consisting of 12 segments.

Strictly speaking, the normal insect larva is composed of 13 segments, and a more or less distinct terminal sub-segment; but in all those larvæ in which the anterior segment is covered by a horny case, so as to form a distinct head, it seems more appropriate to consider this as the head in contradistinction to the twelve articulations of the body. Especially is this the case with Lepidopterous larvæ, which are so plainly marked with a horny head, 12 soft joints and a terminal sub-joint; and this plan has been adopted by most of the leading entomologists, including Boisduval, Guenée, Harris, etc.

In my own descriptions I have always adopted this course, so that when I speak of the first joint I mean that immediately following the head. Of late I have adopted the term *joint* because it is shorter and perhaps more strictly accurate than *segment*. I also discard the term *feet*, as often applied to the horny articulate legs, for they are not feet in any sense of the word, but are the true legs of the insect, and the simple term legs or thoracic legs will at once distinguish them from the abdominal an anal prolegs or false legs.

for this purpose, though it frequently spins up under fence boards and in other sheltered situations. The cocoon is very much like that of the common Tent-caterpillar, being formed of a loose exterior covering of white silk with the hairs of the larva interwoven, and by a more compact oval inner pod that is made stiff by the meshes being filled with a thin yellowish paste from the mouth of the larva, which paste, when dried, gives the cocoon the appearance of being dusted with powdered sulphur exactly as in that of the other species. Three days after the cocoon is completed the caterpillar casts its skin for the last time and becomes a chrysalis of a reddish brown color, slightly dusted with a pale powder, and densely clothed with short pale yellow hairs, which at the blunt and rounded extremity are somewhat larger and darker. In a couple of weeks more, or during the forepart of June, the moths commence to issue, and fly about at night. This moth (Fig. 52, *b* ♀) bears a considerable resemblance to that of the Common Tent-caterpillar (Fig. 51), being of a brownish-yellow or rusty-brown, and having two oblique transverse lines across the front wings. It differs, however, in the color being paler or more yellowish, especially on the thorax; in the space between the oblique line being, even in the males, usually darker instead of lighter than that on either side; but principally in the oblique lines themselves being always dark instead of light, and in a transverse shade, often quite distinct, across the hind wings. As in *Americana*, the male is smaller than the female, with the wings shorter and cut off more squarely. Considerable variation may be found in a given number of moths, but principally in the space between the oblique lines on the front wings being either of the same shade as the rest of the wing, or in its being much darker; but as I have found these variations in different individuals of the same brood, bred either from Oak, Hickory, Apple and Rose, they evidently have nothing to do with the food-plant. The scales on the wings are very loosely attached, and rub off so readily that good specimens of the moth are seldom captured at large. So much for the natural history of our Forest Tent-caterpillar.

THE LARVA SPINS A WEB.

From the very moment it is born till after the fourth or last moult, this caterpillar spins a web and lives more or less in company; but from the fact that this web is always attached close to the branches and trunks of the trees infested, it is often overlooked, and several writers have falsely declared that it does not spin. At each successive moult all the individuals of a batch collect and huddle together upon a common web for two or three days, and during these periods—though more active than most other caterpillars in this so-called sickness—they are quite sluggish. During the last or fourth moult they very frequently come low down on the trunk of the tree, and, as in the case of the gregarious larvæ of the Hand-maid Moth (*Datana* *ministra*), which often entirely denude our Black Walnuts, they unwittingly court destruction by collecting in such masses within man's reach.

IT FEEDS BOTH ON ORCHARD AND FOREST TREES.

In the summer of 1867 this insect did great damage in Western New York, where it is falsely called THE "Army-worm." From the fact that Mr. Peter Ferris, of Millville, Orleans county, N. Y., was greatly troubled with it that year in his apple orchard, and that he did not notice any of the same worms on the Oak and Walnut timber of that section, he concluded that his Apple-feeding worms must be different from those feeding on forest trees. In an article signed "F., Orleans county, N. Y.," which appeared in the *Country Gentleman* of July 23d, 1868, the same writer endeavors to prove his Apple-feeding worms distinct by sundry minute characters, as may be seen from the following extract:

Now I am not an entomologist, but still must be allowed to believe that there are several points, if not "distinctive characters," in which our caterpillar differs from the Tent-caterpillar of the Forest, as described by Dr. Fitch. His larva is of a pale blue color, tinged lower down on each side with greenish-gray. In ours the prevailing color on the back is black; there is a sky-blue stripe on each side but no greenish-gray. Both have the white spots on the back much alike, though perhaps ours are more club shaped, looking to the naked eye nearly the shape of ten-pins. Both have these spots surrounded with black; in ours there is quite a broad black stripe on each side of the spots. This black stripe is more or less filled with fine, crinkled, bright orange lines. In some, these orange lines are so plenty as to be seen plainly without the glass; in others the color to the naked eye is a fine velvet-black. In the larva described by Dr. Fitch there is much less of black and of the fine crinkled lines, which are pale orange-yellow. There is a somewhat broader stripe of the same yellow color, in place of a narrow orange one in ours. The lower yellow stripe may be much alike in both, but what is sky-blue in one is greenish-gray in the other. In both, the head is of a dark bluish color, but in his it is freckled with numerous black dots; in ours, both to the naked eye and under a glass, it is plain. In his "the second segment or neck is edged anteriorly with cream-white, which color is more broad on the sides. The third and fourth segments have each a large black spot on each side." Both the cream white edge and black spots are entirely wanting in our caterpillars.

The habits of the larvæ also appear to be different. According to Harris and Fitch, the Tent-caterpillar of the Forest lives in large societies, under a tent or cob-web-like nest placed against the side of the tree, and comes out to feed on the leaves. Others, as well as myself, have watched our caterpillars and entirely fail to discover that they lived in communities, or in any one place that they went from and returned to. While small, they remain scattered over the smaller branches and on the leaves, and are first seen to begin to get together when about half grown, on some of the higher limbs in the sun. They only collect in large bunches on the trunk and lower limbs; when nearly full grown, and the weather is hot, they get in the shade; and then they never have any web or particular place they return to, or show any uniformity in the size of the bunches. But they only manage in this way while the leaves last. As soon as one tree is stripped they go to another, and when one orchard is used up leave for another. They are great travelers; on a smooth track, like a hard road or a fence cap-board, they get along quite fast. They do not try to keep together, but each one goes on his own hook. There is very little said about the Tent-caterpillar of the Forest traveling in this way.

Then our larvæ appear decidedly to prefer the leaves of the Apple-tree, and only feed on the leaves of other trees when the former are not to be had. Though I am not prepared to say that they will not feed on Oak, Walnut or Hickory trees, under any circumstances, I have repeatedly found these trees in full leaf when not only Apple trees, but Ash and Basswood trees near by, were entirely stripped. The eggs are sometimes laid on Hard Maple shade trees, but the caterpillars leave these trees as soon as they get much size, evidently in search of food more suitable to their taste. This may be the case in regard to Oak and Walnut trees.

They also select different places for their cocoons. Dr. Fitch says the Tent-caterpillar of the Forest selects a sheltered spot for its cocoon, such as the corner or angle formed by the meeting of two or three sides. In this the cocoon is suspended. Our larva selects one or more leaves on any tree that is convenient. The edges of the leaves are drawn together, forming a shelter in which there is generally one cocoon; though when the space is large, and they are very numerous, there are often two or three cocoons together. The cocoon is not suspended, but fastened to the leaf. They spin their cocoons in the forepart of July, and the moths appear in the latter part of the month. The Tent-caterpillar of the Forest spins its cocoon about the 20th of June, and the moth appears in the forepart of July.

Now I think enough has been given to show that two distinct insects are under consideration, but, being only a farmer, I may be mistaken. I would like to see Dr. Fitch's views on this question. Undoubtedly he has read Dr. Walsh's article on "The Three so-called Army-worms," in the *Practical Entomologist*, and can tell whether our caterpillar is a distinct insect, or only shows the variations that may be expected in the Tent-caterpillar of the Forest.

Now since Dr. Fitch has not, to my knowledge, complied with Mr. Ferris's courteous wish, the labor has devolved upon me. I have taken upwards of 200 specimens from the same batch of Oak-feeding worms, and upon critically examining them, find that Dr. Fitch's description is accurate, and that the differences or variations mentioned by Mr. Ferris arise in every case, either from a misapprehension of Dr. Fitch's meaning, or from variations which may be found in the same brood. The only real difference between the two writers lies in the statement of Dr. Fitch that the worms live under a large cob-web-like nest, and that of Mr. Ferris that they do no such thing. Both statements should have been qualified, and were made without sufficient observation; for though the normal habit of the worms is to collect outside of their nests, I have seen exceptional instances of their collecting within or underneath it, especially when young.

Now it is just barely possible that in Western New York there may be a race of these worms that has taken to feeding on Apple and has lost all appetite or become incapacitated for feeding on forest trees; in other words, that there is a phytophagic variety, or a phytophagic species in process of formation. I could mention several similar occurrences among insects,* and to those who believe in the immutability of species these occurrences are incomprehensible enough; but to those who accept the more modern Darwinian views, and believe that species are slowly being formed to-day, just as they have been for long ages and ages in the past, they are most significant, and exactly what we should expect. But that such a race has yet been formed is rendered highly improbable from the following facts: 1st. It is spoken of both by Dr. Fitch and Dr. Harris as occurring on Oak, and by the latter as also occurring on Walnut, Apple and Cherry in the New England States. Mr. George E. Brackett of Belfast, Maine,† in referring to its ravages in the orchard, states that it also ravaged the forests in the summer of 1867, eating the leaves of most kinds of deciduous trees, though Poplar and Ash seemed to be their favorites. 2nd. I have, in our own State, successfully transferred them from Oak to Apple, and from Apple to Oak, and now have a suite of moths bred from larvæ which were fed half the time on the one and half the time on the other. Given an equal quantity of Oak, Apple, Plum, Peach, Cherry, Walnut, Hickory, Rose, they have invariably seemed to prefer and thrive best on the Apple.

IS IT EVER VERY DESTRUCTIVE?

This question is raised by Dr. Fitch, who, on insufficient grounds, discredited the previous assertion of Abbot, that it "is sometimes so plentiful in Virginia as to strip the oak trees bare." The destruction it caused in some of the Eastern States in 1866 and in 1867, is sufficient to decide this question; but there is every reason to believe that in the South and West its injuries are of still vaster extent. From Mr. John H. Evans of Des Arc, Ark., I learn that it last summer completely stripped the over-cup timber in the overflowed bottoms of that country, and for the past two years it has been quite destructive both to forest and orchard trees, in many parts of Missouri. In the Oak timber these worms prefer trees of the Black Oak group, and will seldom touch the White Oak in bodies, though when scattered among the other kinds, they attack it also.

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*For an account of such insects as are known to have phytophagic varieties or phytophagic species I must refer the reader to Mr. Walsh's papers on the subject in the proceedings of the Entomological Society of Philadelphia for 1864 and 1865. But, as the most familiar and striking examples I will mention, first—the polyphagous black-pencilled larva of *Halesidota tessellata*, Sm. and Abb., found feeding on Oak, Hickory, Elm, Plum and other trees, and the monophagous orange-pencilled larva of *H. Harrisii*, Walsh, found exclusively on Sycamore; the moths from the two being absolutely undistinguishable. Second—the yellow-necked larva of *Datana ministra*, Drury, found on Apple and other trees, and the black-necked larva of the same moth found on Black-walnut and Hickory. Third—the large Butternut and Walnut-feeding form of the common Plum Curculio (*Conotrachelus nenuphar*, Herbst.)

†Amer. Journal of Hort., Sept., 1867.

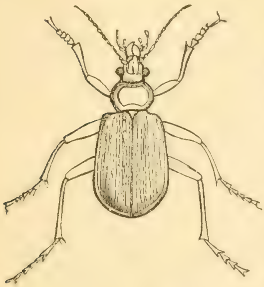
ARTIFICIAL REMEDIES.

From the time they are born till after the third moult these worms will drop and suspend themselves mid-air, if the branch upon which they are feeding be suddenly jarred. Therefore when they have been allowed to multiply in an orchard this habit will suggest various modes of destroying them. Again, as already stated, they can often be slaughtered *en masse* when collected on the trunks during the last moulting period. They will more generally be found on the leeward side of the tree if the wind has been blowing in the same direction for a few days. The cocoons may also be searched for, and many of the moths caught by attracting them towards the light. But pre-eminently the most effective artificial mode of preventing this insect's injuries is to search for and destroy the egg-masses in the winter time when the trees are leafless. Not only is this course the more efficient because it is more easily pursued, and nips the evil in the bud, but for the reason that, in destroying the eggs only, we in a great measure evade killing, and consequently co-operate with, the natural parasites presently to be mentioned, which infest the worms themselves. A pair of pruning shears attached to the end of a pole, and operated by a cord, will be found very useful in clipping off the eggs; or, as recommended by Mr. Ferris, a more simple instrument may be made by fastening a piece of an old scythe to a pole. If the scythe is kept sharp, the twigs may very handily be clipped with this instrument. Tarred bandages, or any of the many remedies used to prevent the female Canker worm from ascending trees, can only be useful with the Forest Tent-caterpillar when it is intended to temporarily protect an uninfested tree from the straggling worms which may travel from surrounding trees.

NATURAL REMEDIES.

It is always wise to co-operate, whenever we can, with our little friends among the Bugs, and it is consequently very necessary to be acquainted with them. It happens, fortunately, that we have several which aid us in keeping the Tent-caterpillar of the Forest in check, and in the natural forest we must trust entirely to these auxiliaries, as the mechanical means that can profitably be employed in a moderate sized orchard are impracticable in broad extents of timber. Indeed, these cannibals and parasites do their work so effectually that this caterpillar is seldom exceedingly numerous for more than two successive years in one locality. It prevails suddenly in great numbers, and again is scarcely noticed for years, very much as is the case with the true Army-worm. Thus, after attracting such general attention in 1867 in many parts of the East, it has scarcely been noticed since. This is its history everywhere, and we may reasonably hope that in those parts of the West where it has been cutting such a figure the present summer, it will suddenly be so subdued as not to be noticed for some years to come. Its undue increase but combines the assaults of its enemies, until they multiply so as to gain the ascendency. Then, from insufficiency of food these enemies suddenly decrease in numbers, and their natural prey has a chance to increase again. And so it goes on in the "Struggle for Life," and in the great complicated net-work in which every animal organism is involved: a check here and a check there, and no one of all the myriad forms allowed to keep the ascendency beyond a limited time. The most efficient cannibal insects in checking the increase of this Forest Caterpillar, are the larger Ground-beetles belonging to the genus *Colosoma*. These beetles will pounce upon the worms with astonishing greed, and are especially prone to attack them when helplessly collected together during the moulting periods. The Rummaging Ground-beetle (*Colosoma scrutator*, Fabr.), which every one will recognize from the figure (54), is especially fond of them. The most common parasite which occurs abundantly in the West, as well as in the East, and which I have bred from several other caterpillars, is a maggot producing a Tachina-fly, which differs only from the Red-tailed Tachina-fly (*Exorista leucaniæ*, Kirk.), which infests the Army-worm, in lacking the red tail.* The other parasite which infests it in the East, but which I have not yet met with, is a species of *Pimpla* very closely allied to *P. melanocephala*, Brullé, but differing from that species in the head being red and not black.†

[Fig. 54.]



SUMMARY.

The Tent caterpillar of the Forest differs from the common Orchard Tent-caterpillar principally in its egg-mass being docked off squarely instead of being rounded at each end; in its larva having a row of spots along the back instead of a continuous narrow line, and in its moth having the color between the oblique lines on the front wings as dark or else darker, instead of lighter than the rest of the wing. It feeds on a variety of both forest and orchard trees; makes a web which from its being usually fastened close to the tree is often overlooked; is often very destructive, and is most easily fought in the egg state.

Exorista leucaniæ, Kirkpatrick = *E. militaris*, Walsh. I have bred the variety lacking the red at tip of abdomen from larvæ of *Attacus cecropia*, Linn., *Datana ministra*, Drury, *Agrotis inermis*, Riley, and of two undetermined Agrotidians.

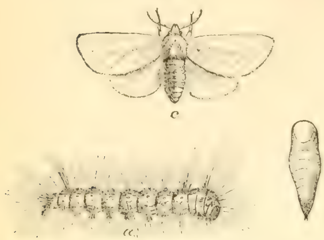
†*Practical Entomologist*, II, p. 114.

THE FALL WEB-WORM—*Hyphantria textor*, Harris.

(Lepidoptera, Arctiidæ.)

With the two preceding caterpillars is often confounded a third which in reality has nothing in common with them, except that it spins a web. The insect I refer to is known by the appropriate name of Fall Web-worm, and whenever we hear accounts of the Tent-caterpillars taking possession of trees and doing great injury in the fall of the year (and we do hear such accounts quite often), we may rest assured that the Fall Web-worm is the culprit and has been mistaken for the Tent-caterpillars, which never appear at that season of the year.

[Fig. 55.]



I do not know how injurious this insect is in the more Southern States, but he who travels in the fall of the year, with an eye to the beauties of the landscape, through any of the Northern and Middle States, especially towards the Atlantic sea-board, will find the beauty fearfully marred by the innumerable webs or nests of this worm. If they are as common as they were last fall, he will very naturally deplore the unsightly appearance of the forests, and feel amazed at the number of these signs of carelessness and slovenliness which occur in the cultivated orchards! The Web-worm is found on a great many kinds of trees, though on some more abundantly than others; but with the exception of the different grape-vines, the evergreens, the sumachs and the Ailanthus, scarcely any tree or shrub seems to come amiss to its voracious appetite. This insect passes the winter in the pupa state under ground and the moth emerges during the month of May or as late as the fore part of June. The female deposits her eggs in a cluster on a leaf, generally near the end of a branch, and these eggs hatch during the months of June, July and August, earlier or later, according to the latitude. Each worm begins spinning the moment it is born, and by their united effort they soon cover the leaf with a web, under which they feed in company, devouring only the pulpy portions of the leaf. As they increase in size they extend their web, but always remain and feed underneath it. When young the worms are pale-yellow with the hairs quite sparse and with two rows of black marks along the body and a black head. When full grown they generally appear pale-yellowish or greenish with a broad dusky stripe along the back and a yellow stripe along the sides, and they are covered with whitish hairs which spring from black and orange-yellow warts. Figure 55, *a*, gives a very good idea of a full grown worm, but the species is very variable both as to depth of coloring and markings.

Both Dr. Harris and Dr. Fitch state that this worm spins its thin cocoon in crevices of bark and similarly sheltered places above ground, but a great many of the specimens which I have reared (and I have bred specimens three different years) buried themselves and formed their cocoons just under the surface of the ground—thus giving evidence that the same insect will sometimes variously spin up above or below the ground. The chrysalis (Fig. 55, *b*) is of a very dark brown color, glabrous and polished and faintly punctured, and is characterized by swelling or bulging about the middle. The moth (Fig. 55, *c*) is white with a very slight fulvous shade: it has immaculate wings, but the front thighs are tawny-yellow and the feet blackish: in some the tawny thighs have a large black spot, while the shanks on the upper surface are rufous; in many all the thighs are tawny-yellow, while in others they have scarcely any color. One bred specimen in my cabinet even has two tolerably distinct spots on each front wing—one at base of fork on the costal nerve, and one just within the second furcation of the median nerve.

During the summer and fall of 1870 this worm was unprecedently numerous, not only in our own State but all over the country, and, as was remarked by others as well as myself, it hatched out much earlier than usual; for the first webs were noticed around St. Louis by the middle of June. It has always been supposed to be single-brooded, and in the New England States it never does perhaps produce more than one brood each year; but though such may be its normal habit, even in the latitude of St. Louis, yet there is good evidence that it sometimes produces two broods in that latitude, and in all probability does so constantly still further south. There appeared to be two broods with us the present year, and Mr. J. R. Muhleman, of Woodburn, Illinois, informed me that on August 5th, he had a second brood of worms, the first brood having appeared in June on Pear and Osage Orange. He did not, however, breed one generation from the other, and until this is done during the same year, we cannot say with absolute certainty that the species is two-brooded, for the disparity in time of appearance can be accounted for in other ways. The climate of the Central portion of our State is intermediate between that of the more Northern and the more Southern States, but the fauno partakes more of the character of the latter; and our summers are so variable in their duration and in their general intensity, that our insects show a great variability in their habits. It is for this reason that I find it very difficult to draw the rigid lines that many of our New England writers have done when treating of a particular insect, and it is for this reason that we frequently find insects, normally single-brooded there, often producing two broods a year here.

With us the Fall Web-worm appears to be most partial to the hickories and to the Black walnut, and least so to the oaks; but I have found scarcely any tree or shrub exempt from its attacks except those already mentioned, and it is even said to feed on the Hop-Plantain, Bean, Sunflower, and many other herbaceous plants.

From the foregoing account it will at once be seen how widely this Fall Web-worm really differs from the Tent-caterpillars. It hibernates in the pupa state, they in the egg state; it appears mostly in the fall, they mostly in the spring; its moth is pure white, theirs reddish brown; its eggs are deposited on a leaf, and hatch before the leaf falls, theirs are deposited around a twig, because they have to pass the winter and would get lost with the leaves if deposited upon them; it feeds solely on the parenchyma of the leaf under its web, they devour the whole leaf outside of their tent; and on account of these differences, we cannot employ the preventive measures against it which we take against them.

REMEDIES.

As, therefore, nothing can be done to materially affect this insect during the winter, we must do all the fighting when the worms first hatch. Their web soon betrays them, and the twig or branch containing it may be pruned off in the same manner described for the Tent-caterpillars. As the worms are always under the tent, the operation in this case can be performed at any time of the day without the risk of missing any wanderers.

HYPHANTRIA TEXTOR—*Larva*—(Fig. 55, *a*) Ground-color greenish-yellow. Dorsum velvety-black, with a narrow median pale line on thoracic joints. Sides speckled with black, except along subdorsal and stigmatal lines, where longitudinal yellow patches are left clear. Venter dusky or smoky-brown. Head shiny black with labrum and antennæ white. Thoracic legs black; prolegs long and narrow, smoky-black with faint orange extremities. Covered with long straight hairs, longest on joints 2, 3, 11 and 12. These hairs are either dirty white with a few black ones interspersed, or of a more uniform reddish-brown. They spring in bundles from around large warts situated as follows on each joint; 4 which are black and dorsal, arranged in a trapezoid, the anterior pair being the smaller; and four which are orange on each side, and arranged in a transverse row in the middle of the joint. Stigmata light yellow. Average length, 1.10 inches.

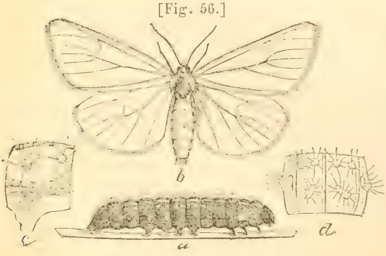
Varies considerably, in some the black predominating, in others the yellow. Those found on hickories are usually the darkest. When newly hatched it is pale yellow with two longitudinal rows of black marks and a black head.

Described from numerous specimens.

THE BLUE-SPANGLED PEACH WORM—*Callimorpha fulvicosta*, Clem.

(Lepidoptera, Arctiidæ.)

[Fig. 56.]



In examining apple trees, but more especially peach trees, during winter or early spring, we often come across little black worms, covered with short, stiff, sprangling hairs, and studded with minute blue spots, sheltering under the loose bark. As soon as the leaves put out, these worms issue from their winter retreat and commence feeding. They grow apace and by the end of April have usually acquired their full size, when they present the appearance of Figure 56, *a*; *c* showing an enlarged side section of one of the principal joints, and *d* a back view of the same. The color is now velvety black above, and pale bluish, speckled with black below; there is a deep orange line along the back, and a more distinct wavy and broken one along each side: the warts, illustrated in the enlarged sections are steel-blue and granulated, and their irregularities, as they catch and reflect the light, look like minute pale blue diamonds, the whole body, upon casually glancing at it, appearing studded with these blue points. This worm spins a slight cocoon of white silk in any sheltered place it can find, and changes to a chrysalis of a purple-brown color, finely and thinly punctured and terminating in a horizontally flattened plate, which is furnished with numerous yellowish-brown curled bristles. The moth (Fig. 56, *b*) issues from this chrysalis during the fore part of June. It is a very plainly marked species, being either milk-white or cream-colored, with the head, collar, basal and apical joints of the abdomen above, and the whole body, legs, and anterior margins of the wings fulvous or dull orange.* It was described in 1860 by Dr. Brackenridge Clemens under the name of *Hypercompa fulvicosta*† but is now properly referred to the genus *Callimorpha*. It may be known in English as the Cream Callimorpha as it is disguised from all other moths by its unspotted creamy appearance.‡ This worm is found more commonly on

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**Callimorpha vestalis*, Packard (Proc. Ent. Soc. Phil. III, p. 108), must be considered as a synonym of *fulvicosta*, for Dr. Packard has certainly given no characters that should be considered specific. To show on what grounds the new species is founded I will quote in full the original description of *fulvicosta* and afterwards that of the so-called *vestalis:*

C. fulvicosta, Clem.—"White. Palpi yellow orange, tips blackish. Head prothorax, the anterior edge of the fore wings, especially beneath, yellow-orange; sometimes the costa of the fore wings is dark brownish. Breast and legs yellow orange, the middle and fore tibiæ and tarsi blackish. Abdomen tipped with yellowish orange.
"Illinois. From Robt. Kennicott."

C. vestalis, Pack.—"♂ and ♀ pure immaculate milk-white, ♀ white. Tips of the palpi brown. Head and prothorax, basal half of the patagia and costa of both wings above and beneath yellowish. The legs are also yellow beneath. The abdomen is white and unspotted. Antennæ brown. Body ♂ .65, ♀ .65. Exp. wings ♂ 1.70, ♀ 1.70 inch.
"Middle Atlantic States (Coll. Ent. Soc. Phil., through A. R. Grote."

Now, comparing the descriptions, *vestalis* differs in no other respect from *fulvicosta*, than in the legs being yellow beneath instead of having the middle and fore tibiæ blackish as described by Clemens. Three bred specimens in my possession differ in this trifling character, and though Dr. Packard says that his species differs *remarkably* [*!!*] from the other in being pure white and of smaller size, yet Dr. Clemens gives no measurements and there are specimens in my own cabinet and in Mr. Walsh's of all shades of white to cream color and some of them fully as small as the measurements above quoted. Moreover I have a specimen marked *vestalis*, kindly sent me by my friend Cresson of the Am. Entomological Society, and while in Philadelphia last fall I examined all the specimens marked or said to be *vestalis* without finding any distinguishing characters at all. If a new species is to be made out of such trifling characters in the face of the fact that the species of the genus *Callimorpha* are very prone to vary, and that twenty times as much variation is found in hundreds of other species of Lepidoptera, what is the science of entomology to come to?

†Proc. Acad. Nat. Sci. Phil., 1860, p. 536.

‡The only insect which very closely resembles it is a pale variety of a moth known as the Egle (*Euchœtes egle*, Harr.) whose beautiful larva is tolerably common on our milkweeds. This last however may always be distinguished by the feathered antennæ of the male, the different shaped wings and the deep orange and black spotted abdomen.

the Peach than on any other tree, and as it appears very early in the season and commences to feed on the young leaves before they are fully expanded, it does considerable damage when numerous. I have been acquainted with the worm for several years past but its natural history was unknown till last summer when Dr. LeBaron and myself simultaneously bred the moth from peach-leaf feeding larvæ, so that its history is now given for the first time. Figures of the larva were given in the *Prairie Farmer* last summer by Dr. LeBaron who was misled by Dr. Hull into the belief that they were the Tent-caterpillar of the Forest already described. Two years ago I found this Blue-spangled worm tolerably common in the peach orchard of Mr. E. J. Ayres of Villa Ridge, Ills., and he says that he destroyed over a thousand of them last spring. In this State I have frequently met with it but it is by no means common. Hand picking will easily keep it in check.

CALLIMORPHA FULVICOSTA, Clem.—*Larva* (Fig. 56, *a*)—Color velvety-black above, pale bluish-gray speckled with black below. A deep orange medio-dorsal line (usually obsolete towards each end) and a more distinct, wavy, broken, yellow stigmatal line, with a less distinct coincident pale line below it. Covered with large highly polished, roughened, deep steel-blue warts, the irregularities of which as they catch and reflect the light, look like pale blue diamonds. Closely examined these warts are found to be covered with small elevations each of which furnishes a short stiff yellow hair, these hairs radiating in all directions around the warts, which are placed as follows:—Joint 1 with an anterior transverse row of 8 and a posterior dorsal row of 4; joints 2 and 3 each with a transverse row of 8 across the middle; joints 4—11 inclusive, each with 4 circular ones anteriorly, and 2 irregular ones posteriorly on dorsum (Fig. 56 *d*, each of the last evidently formed by the blending of two), and 2 on each side near the middle of joint (Fig. 56 *c*). Joint 12 with 2 that are irregular, on the back, and 1 that is circular, on each side. Anal shield formed of one large irregular wart. In addition to these there is a narrow subventral wart each side, and 2 small ventral ones on the legless joints. Head polished black with a few black hairs. Thoracic legs polished black, but pale at the joints inside: prolegs black outside, flesh-colored within and at extremities. Stigmata not perceptible. Largest in the middle of body. Average length 0.90, greatest diameter 0.15 inch.

Described from 6 peach-feeding specimens. Alcoholic specimens do not reflect the pale blue points.

The larvæ of our different *Callimorphas* seem to bear a very close resemblance to each other. I have bred *C. clymene*, Hubner, from a larva found full grown on oak (tho' whether it fed on oak I did not ascertain) which so resembled that of *fulvicosta* that I fully expected it would produce nothing else. The only difference noticeable was that it was very bright colored, with the medio-dorsal line very clear and distinct. Mr. Wm. Saunders has reared *C. LeContei* from larvæ feeding on Horse Gentian (*Triosteum perfoliatum*), and from his description of the larva* it differs principally from the above in lacking the blue reflections and in having a pale dotted subdorsal line.

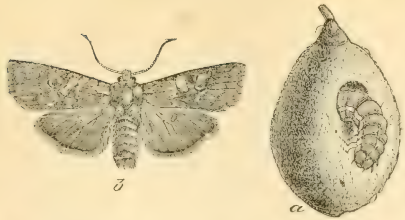
THE ASH-GRAY PINION—*Xylina cinerea*, N. sp.

(Lepidoptera, Xylinidæ).

There is a pale green worm with cream-colored spots and a broad cream-colored lateral band, which I have for several years known to

* *Canadian Entomologist* I, p. 20.

[Fig. 57.]



be common on the Apple, Poplar, Hickory and some other trees, the leaves of which it devours, but which last summer attracted unusual attention by its being frequently found boring into apples and peaches, and as I also commonly found it hiding in and feeding upon one of our large oak-apples (the *spongifica*) we may conclude that it is a very general feeder and that it is fond of boring.

This worm (Fig. 57, *a*) is found during the months of May and June and when full grown burrows beneath the surface of the ground where it forms a very thin cocoon of filmy silk with the earth adhering to it on the outside. It changes to a mahogony-brown chrysalis and generally issues as a moth during the September or October following, though in northern Illinois I have known it to remain in the chrysalis state through the winter and not issue as a moth till April.

The moth (Fig 57, *a*) varies considerably in its appearance, but is characterized by the cold ash-gray appearance of the front wings which are variegated with darker gray as in the figure. It is an undescribed species and belongs to a genus (*Xylina*) which is easily recognized by the long narrow almost rectangular wings, the very square thorax which is often furnished behind the collar with a bifid crest, and the rectangular and flattened abdomen. The wings are folded in repose and appear almost parallel and like a flattened roof—giving the insect an elongate appearance.

XYLINA CINEREA, N. Sp.—*Larva* (Fig. 57, *a*.) Length when full grown 1.20—1.30 inches, color shiny silvery-green on the back, darker below. A medio-dorsal cream-colored stripe; a subdorsal one represented by 3 or 4 irregularly shaped spots on each joint. A broad deep cream-colored stigmatal line, with a few green dints in it, extending to anal prolegs. Four slightly elevated cream-colored spots, encircled by a ring of rather darker green than the body, in the dorsal space, and in the subdorsal space there are four or more similar but smaller spots. Venter glaucous-gray. Head as large as joint 1, free, glassy-green with white mottlings at sides and top, and pearly-white lips. Thoracic legs whitish. Prolegs concolorous with venter. When young the body is darker and the markings paler.—Described from two living specimens.

Imago (Fig. 57, *b*)—*Front wings*, with the ground-color pale cinereous shaded and marked either with light brown, having a faint purplish tint, or with darker brown, having a similar reflection, or with a colder grayish-brown with the faintest moss-green reflection: in the first two cases the dark color either blends and suffuses with the ground-color so as to give the wing a nearly uniform and smooth appearance, or else contrasts sufficiently to bring out all the marks distinct; in the latter case (two specimens) the markings are very distinct and the ground color is whiter and more irrorate. In the well marked specimens the usual lines are readily distinguished, the basal half line, transverse anterior and transverse posterior being quite wavy, pale, and bordered each side with a dark shade, the median shade dark and well defined and the subterminal line, though sometimes pale near costa, forming a series of dark angular spots: in the more uniform specimens these lines are barely distinguishable and perhaps the most constant is the sub terminal which most often takes the form of a series of dark angular spots: the ordinary spots have a pale inner and a more or less distinct dark outer annulation; the orbicular is larger than the reniform and is sufficiently double to take on the form of an 8, the upper part of which is always largest and with the interior space paler than the general surface, while that of the lower part is either concolorous or darker; the form is, however, quite irregular and differs sometimes in the two wings of the same species: the reniform spot is generally well defined, and is either darker, or has a tinge of reddish-brown, interiorly: at the base of the wing is a more or less distinct pale space occupying the upper half, and bordered below by a brown line which is straight about half its length and then extends upwards and outwards towards transverse anterior. A tolerably distinct terminal line, with the fringes dark. In taking a general view of the varying specimens this pale basal space, the pale upper part of the orbicular and the dark subterminal line, seem to be the most constant characters of the species. *Hind wings* gray-brown inclining to cinnamon-brown, with the posterior border but slightly darker and the fringe paler. Under surface quite uniform, that of front wings being nacreous gray with a faint discal spot and with a narrow costal and broad terminal border of pale fulvous, dusted with purple-gray; the hind wings of this last color with the lunule and line distinct. *Head* nearly entire, though the quadrifid arrangement of the hairs is traceable; palpi hairy throughout. *Thorax* quite square, of same color as primaries and with the collar bordered behind with brown and sometimes the edges of the tegulæ similarly bordered. *Abdomen* of same color as hind wings with lateral tufts, and cut off squarely at apex. Expanse 1.32—1.82 inches.

Described from 3 specimens fed on grape-vine, 2 on peaches and 1 on *Cercis canadensis*. Other captured specimens examined.

This species is the analogue of, and very closely resembles the European *Xylina conformis*, which is known under various synonyms. A specimen sent to Mr. P. C. Zeller of Stettin, Prussia, was, however, pronounced distinct. The well-marked irrorate form still more closely resembles Guenée's *cinerosa* found in Switzerland, and which he himself thinks may prove to be a variety of *conformis*. The more I study the species of the NOCTUIDÆ as they occur in nature, the more I am struck with their great variability, and there can be no doubt that many of the so-called species will turn out to be but varieties when we better understand them. In this large family none but the more strikingly marked species should ever be described without an accompanying description of their preparatory states and of their principal variations. I am unacquainted with any of Walker's species except *subcostalis* which is very different, and if this should prove to be a synonym of any of them, the fault must be laid to the difficulty under which the naturalist in the Western States labors for want of proper libraries to refer to. It differs essentially from Grote's *Bethunei* and *capax* as described and illustrated in Volume I of the Transactions of the American Entomological Society. I am informed by Mr. A. Lintner of Albany, N. Y., that Dr. A. Speyer of Rhoden, Furtsenthum Walldeck, Prussia, who gives much attention to the Noctuidæ, has it marked *Celæna oblonga* in his MS., but the insect evidently does not belong to that genus, and as the German pronunciation of *Xylina* much resembles the English pronunciation of *Celæna*, the reference to the latter, is doubtless due to a verbal misunderstanding.

BENEFICIAL INSECTS.

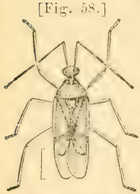
It is not often that there will be much to say in this Department, as most of the beneficial insects are treated of in connection with the injurious species upon which they prey. But the following little fellow is so important to the grape-grower that it should be recognized by every vineyardist in the State, and cherished as the very apple of his eye:

THE GLASSY-WINGED SOLDIER-BUG—*Campyloneura vitripennis,* Say.

A NEW FRIEND TO THE GRAPE-GROWER.

This is the bug; and a pretty little thing it is too! Take a good look at the figure and remember that the hair-line at the side represents the natural size.

[Fig. 58.]

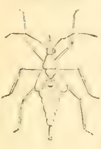


There are perhaps no insects more dreaded by the grape-grower than the different species of leaf-hoppers which sap up the substance of the leaves of the Vine; but as they will be treated of, in all probability, in my next Report, we will pass them over for the present.

No parasitic or cannibal insect has ever been known to prey upon these leaf-hoppers before, but last September, while in the vineyard of Dr. C. W. Spaulding, at Rose Hill, on the Pacific railroad, I discovered that this Glassy-winged Soldier-bug was preying upon them. The leaves were actually covered on the underside with the dead carcasses of the leaf-hoppers, which, in their death-struggle, had firmly attached themselves, and hung thickly, with wings extended and body sucked dry—dead proof of the surprising thoroughness with which their mortal foe had done its work of slaughter. On a single leaf not so large as a man's hand a half hundred of these skeleton leaf-hoppers could be counted, and though this number was above the average, there were few leaves that did not show quite a number. To use Dr. Spaulding's language, "the sight was enough to gladden the heart of any grape-grower, who had long looked upon the leaf-hopper as a permanent evil against which he could not successfully contend."

Moving about among the leaves our little Soldier-bug* was often seen in its pretty full dress uniform, but far more commonly disguised in its larval or pupal coat; for it is only when full grown and full fledged that it presents the appearance of the first figure. The larva and pupa both have an opaque, mealy, bluish-white appearance, and the

[Fig. 59.]



latter differs only from the former in the more conspicuous wing stubs, which project so as to give it a somewhat diamond shaped outline (Fig. 59.) It is during these immature, and less conspicuous stages that this insect doubtless does most of its work, for in common with the rest of the true Bugs (*Heteroptera*) it is active and feeds during its whole life, from the time it hatches from the egg till it dies of old age.

When I first saw the hosts of leaf-hoppers so mercilessly stabbed, I was at considerable loss to understand what animal could be so wary and dexterous as to surprise insects so shy and active, and with such wonderful jumping powers as the leaf-hoppers possess, and I could not rest sure that it was our little Glassy-winged Soldier-bug till I had enclosed specimens in a bottle with living leaf-hoppers, and found the latter dead next day. Like many other animals of prey, it can move actively when necessary, but no doubt prefers to surprise its victims by stealth, assisted perhaps by its colors which resemble those of the leaf-hoppers themselves.

The more common color of this insect is pale greenish-yellow. The antennæ are brown with the basal joint and sometimes part of the second joint blood-red. The head and thorax are pale yellow with a slight tinge of pink, and the eyes, neck, and front part of the thorax, except a pale line on the back, are jet black in high contrast. The scutel is pale yellow or white, and black at base, and the upper wings (hemelytra) are beautifully transparent with a rose-colored cross band and a dusky curved line. The species is a very variable one, however, being dichromous or double-colored, some varieties possessing much more brown than others, and having no rose-color at all. In a variety kindly sent me by Mr. P. R. Uhler, of Baltimore, Maryland, the antennæ are pale, and there is no black on the thorax in front, but a large brown patch behind; there is also a large brown patch each side of the scutel, and the rosy transverse band on the wings is quite brown.

Now this insect is commonly found by collectors in the fall of the year on different kinds of Oak, but no one ever heard before of its

* I have preferred to apply this popular term to this species, because its black, white and red marks, and its war-like propensities suggest something of the sort; and though the term is more strictly and correctly applied to larger cannibal bugs belonging to the genus *Arma*, yet it is not inappropriate here, and will appeal to the popular mind far more readily than the generic name *Campyloneura*, or the English rendition of it, curved-nerve.

attacking the leaf-hoppers of the Grape-vine, and it certainly could not have done so in past years to the extent that it did at Rose Hill last fall, without its work having been noticed. I have been through vineyards by the hundred in the fall of the year, and never before noticed such work. How are we then to account for its sudden appearance in such force in the vineyard of Dr. Spaulding? To my mind it is an excellent illustration of an insect acquiring a new habit. Some individual or individuals wandering from the oaks and from whatever food they there subsisted upon, came upon Dr. Spaulding's vineyard and found the leaf-hoppers of the Vine to their taste. Their food being abundant, they soon multiplied, so as to make their work appreciable, and commenced to spread from one vineyard to another. The facts in the case would support such a theory, for the bugs and their slaughtered victims were found in diminishing numbers in the vineyards in the immediate neighborhood until at the distance of three miles, no sign of either could be found. Consequently, though our little cannibal friend occurs sparingly throughout the country in the native timber, it is found in the cultivated vineyard in a limited district only, so far as we now know. But there is no reason why the field of its operations in the vineyard should not in time become co-extensive with that of the troublesome leaf-hoppers; and with our present mail facilities we can materially help to make it so by artificially introducing a few dozen of the living bugs from one vineyard to another.

This species was first described by Say as *Capsus vitripennis*. The *Phytocoridæ*, as the name indicates, have all been hitherto considered as plant-feeders, and at first the species above considered would appear to be an exception to the unity of habit in the family. But Mr. Uhler informs me that his investigations of the elongated forms of many of the recently established genera have taught him that the affinities of many of them are largely with the *Reduviidæ* through *Anthocoridæ*; for he has often found them in places where small caterpillars were numerous; among the larvæ of *Tingidæ*, and has even caught them in the act of sucking the juices of plant-lice.

INNOXIOUS INSECTS.

THE WHITE-LINED MORNING SPHINX—*Deilephila lineata*, Fabr.

(Lepidoptera, Sphingidæ.)

[Fig. 60.]

The beautiful moth which heads this chapter is quite common in the State of Missouri, and has upon several occasions been sent to me for identification. Almost every one must have been struck with the great resemblance which it bears to a humming bird, as, of a summer's evening, it flits rapidly from plant to plant in the garden, and ever and anon hovers noiselessly over some particular flower, and stretches forth its long tongue to sip the sweet nectar which that flower contains.

Few persons are, however, aware what this beautiful moth looks like, or what it feeds upon, in the caterpillar state; wherefore this brief account of it.

The very great diversity of form and habits to be found amongst the larvæ of our butterflies and moths, has much to do with the interest which attaches to the study of these masked forms. I am moved to admiration and wonder as thoroughly to-day as in early boyhood, every time I contemplate that within each of these varied and fantastic caterpillars—these creeping and groveling "worms"—is locked up the future butterfly, or moth, which is destined, fairy-like, to ride the air on its gauzy wings, so totally unlike its former self. Verily the metamorphoses of the lower animals must prove a never-failing source of joy and felicity to those who have learned to open the pages of the great Book of Nature!

But beyond the general satisfaction experienced in studying these transient forms, there will be found ample food for the philosophic mind in the larval variations to be met with in the same species. Some vary according to the character of their food-plant, and the study of these variations—of phytophagic varieties and phytophagic species—must ever prove interesting as well as important, by throwing light on the question of the origin of species. Some (*e. g.* the common Yellow Bear, Fig. 28, *a*, p. 68) vary very much without regard to food-plant. Our Sphinx larvæ, more particularly, are subject to these variations, and it is for this reason that larval characters alone, unaccompanied by those of the perfect insect, are of so little value in classification.

The White-lined Morning Sphinx (Fig. 60) presents one of the most striking cases of larval variation, as may be seen by comparing the light form of Figure 61 with the dark form of Figure 62. In the summer of 1863 I took both these forms on the same plant, and have repeatedly met with them since; but the moths bred from them show no differences whatever.

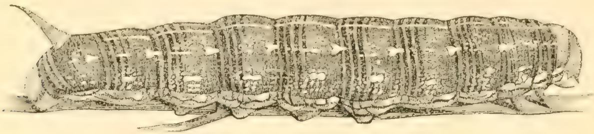
This beautiful moth is called by Harris the White-lined Morning Sphinx, though its generic name means "Evening Friend." It is distinguished principally by its roseate under-wings, and by a broad, pale band running from the apex to the base of the dark-olive front wings.

[Fig. 61.]

The larva feeds upon purslane, turnip, buckwheat, watermelon, and even apple and grape leaves, upon any of which it may be found in the month of July. It descends into the ground and, within a smooth cavity, changes into a light brown chrysalis, from which the moth emerges during the month of September.

The most common form of this larva is that given at Figure 61; its color is yellowish-green, with a prominent subdorsal row of elliptical spots, each spot consisting of two curved black lines, inclosing superiorly a bright crimson space, and inferiorly a pale yellow line—the whole row of spots connected by a pale yellow stripe, edged above with black. In some specimens these eye-like spots are disconnected, and the space between the black crescents is of a uniform cream-yellow. The breathing-holes are either surrounded with black, or with black edged with yellow. The other form is black, and characterized chiefly by a yellow line along the back, and a series of pale yellow spots and darker yellow dots, as represented in the illustra-

[Fig. 62.]



tion (Fig. 62). Even this dark form is subject to great variation, some specimens entirely lacking the line along the back, and having the spots of different shape.

This insect has a wide range, as it occurs in the West Indies, Mexico and Canada, as well as throughout the United States. Feeding, as it does, principally on plants of but little value, and being very commonly attacked by the larva of a Tachina-fly, this insect has never become sufficiently common to be classed as injurious. The Tachina-fly which so commonly infests it, is readily distinguished from the other more common form by the abdomen, which is bright rufous with the exception of a broad dorsal stripe which is dark.

TWO OF OUR COMMON BUTTERFLIES.

THEIR NATURAL HISTORY; WITH SOME GENERAL REMARKS ON TRANSFORMATION AND PROTECTIVE IMITATION AS ILLUSTRATED BY THEM.

In the following pages I propose to give the complete natural history of two of our commonest butterflies, and to close with such philosophical thoughts as the subject warrants. I do so the more willingly as many of the facts are published for the first time; for notwithstanding the butterflies are so common, their complete natural history has hitherto been unknown.

THE ARCHIPPUS BUTTERFLY—*Danais archippus*,* Fabr.

(Lepidoptera, Danaidæ.)

ITS NATURAL HISTORY.

[Fig. 63.]

"What more felicitie can fall to creature
Than to enjoy delight with libertie,
And to be lord of all the workes of Nature,
To raine in th' aire from earth to highest skie,
To feed on flowres and weeds of glorious feature."
The Fate of the Butterfly—Spenser.

This beautiful butterfly, like most of the species of the family to which it belongs, enjoys a wide range, occurring in the more northern of the States and in Upper Canada and extending into South America, where, according to Mr. Bates, it is common throughout the region of the Lower Amazons.† In the Mississippi Valley it is one of our most common species. The family to which it belongs is distinguished by the front legs being spurious or abortive; by the large cell in the centre of each wing being closed, and by the existence of a small nervule originating at the base of the front wing just below the lower or sub-median nerve, and joining that nerve a short distance from its base.‡ This nervule is so covered with scales that it is hardly visible till they are removed. In the genus *Danais* the sexes are readily distinguished by the male having a small horny

* Some late writers use the specific name *erippus* of Cramer, because it seems to have the priority. I have not all the works of the old authors to refer to, but Mr. Sanborn, of Boston, has been kind enough to refer to them for me, and he writes that *erippus* was first applied by Cramer to the ♀ in 1775, and *plexippus* to the ♂ by the same author in 1780. Fabricius published his name of *archippus* in 1793, and the name had already been applied by Cramer to the Disippus butterfly. Accordingly Cramer's *erippus* has the priority; but as this insect has been very generally known by the name which Fabricius gave it, among entomological writers, and as it has become familiar to the popular ear, I prefer to retain it—especially since it is no longer applied to the Disippus butterfly.

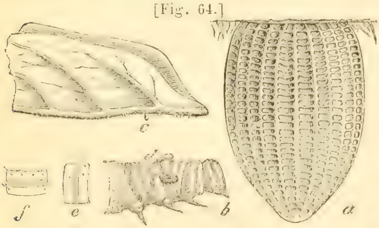
†Trans. Linnæan Soc., Vol. XXIII, p. 516.

‡Mr. Bates in a note to the paper already referred to, (p. 497,) gives this as a constant and excellent character discovered by Dr. C. Felder, of Vienna, and describes it as "a small nervule at the base of the fore-wing median nervure which anastomoses with the median a short distance from ts origin." I have no means of referring to Dr. Felder's original article, and cannot say whether e is correctly quoted; but in the two N. A. species of the genus (*D. archippus* and *berenice*) this nervule originates below and anastomoses with sub-median nerve.

excrescence near the disk of the hind wing, close to, or upon the fourth nerve. This excrescence or tubercle is faintly shown in the above figure, which represents the male, and it is entirely lacking in the female. The color of the Archippus butterfly is of a bright orange-red, marked with black and cream-color as in the figure—the underside being similarly marked but paler, that of the hind wings being bright fulvous. The species feeds upon most of the different kinds of Milk-weed or Silk-weed (*Asclepias*), and also upon Dogbane (*Apocynum*), according to some authors. It shows a wonderful dislike, however, to the Poke Milk-weed (*Asclepias phytolaccoides*), and I was surprised to find that larvæ furnished with this plant would wander about their breeding cages day after day, and would eventually die rather than touch it, though they would eagerly commence devouring the leaves of either *A. tuberosa*, *curassavica*, *cornuti* or *purpurascens* as soon as offered to them.

The butterflies hibernate, though whether any but the impregnated females survive until the Milk-weeds commence to grow is not definitely ascertained. They commence depositing eggs in the latitude of St. Louis during the fore part of May. Some of the earliest developed butterflies from these eggs begin to appear about the middle of June and others continue to appear for several weeks. These lay eggs again, and the butterflies abound a second time in October. Thus there are two broods each year, and though the first brood of larvæ are hatched more uniformly and within a more limited time than the second, the two broods yet connect by late individuals of the first and early individuals of the second, and the caterpillars may be found at almost any time from May to October, but are especially abundant during late summer and early fall.

[Fig. 64.]



The egg (Fig. 64, *a*, magnified; *c*, natural size) is invariably deposited on the under side of a leaf, and is conical and delicately reticulate with longitudinal ribs, and fine transverse striæ. It is yellowish when first deposited but becomes gray as the embryo within develops.

Description of Egg.—Length 0.05; greatest diameter 0.03 inches. Conical, slightly narrower at base than in middle, and generally slightly contracted towards apex. Color pale cream-yellow; opaque, smooth; the shell but slightly polished and rather soft. About 22 longitudinal narrow carinate ribs, usually regular and single, though occasionally one gives forth a branch; interstices crossed by about 30 very fine transverse striæ, often subobsolete. Apex smooth. Slightly and singly attached to the underside of leaf.

Described from numerous specimens.

It is a little singular that this egg has not previously been described. It is very easily found, and I had no difficulty in obtaining great numbers last summer, though I owe the first one ever obtained to the sharp eyes of Miss M. E. Murtfeldt, of Kirkwood, a lady who takes much interest in Entomology, and is an excellent observer. It were greatly to be wished that more of our ladies would interest themselves in such studies, for we have altogether too few Madam Merians.

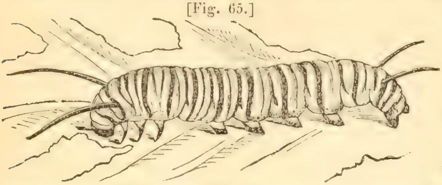
In about five days after deposition, the egg hatches, and the young larva as soon as hatched usually turns round and devours its egg-shell; a custom very prevalent with young caterpillars. At this stage it differs considerably from the mature larva; it is perfectly cylindrical, about 0.12 inch long and much of a thickness throughout. The head is jet black and polished; the color of the body is pale greenish-white with the anterior and posterior horns showing as mere black conical points, and with two transverse-oval black warts, nearer together, on the first joint. It is covered with minute black bristles, arising from still more minute warts, six on the back and placed four in a row on the anterior portion and one each side on the posterior portion of each joint, (Fig. 64, *f*); and three on each side, one in the middle of the joint, and two which are substigmatal, posteriorly, (Fig. 64, *e*.) There is a sub-triangular black spot on the anal flap, the legs are alternately black and white and the stigmata are made plainly visible by a pale shade surrounding them. When the young worm is three or four days old, a dusky band appears across the middle of each joint; and by the fifth or sixth day it spins a carpet of silk upon the leaf, and prepares for its first moult. After the first moult the anterior horns are as long as the thoracic legs, the posterior ones being somewhat shorter; the characteristic black stripes show quite distinctly, but the white and yellow stripes more faintly. After this it undergoes but slight change in appearance, except that the colors become brighter and that at each successive moult the horns become relatively longer. There are but three moults.* and the intervals between them are short, as the worms frequently acquire their full growth within three weeks from hatching.

Some persons may be curious to know how the larva acquires longer horns at each moult. The explanation is simple. During each period of growth the skin which is to serve for the next period is forming and perfecting under that which at the the time serves the worm. Upon this inner skin and beneath the outer one, the horns are also developing, and when the outer skin has become useless and the worm, after a short period of rest and fasting, bursts it near the head and works it off, the old horns go with the old skin and the new ones appear as mere stubs. The new skin is now very fresh and moist, and no sooner is the old skin off than these soft stubs begin to swell, and it is then easily seen how wonderfully the long horns

*I do not include the last moult by which the larva is transformed to the chrysalis. Some persons in counting the different moults that larvæ pass through, are content with counting the heads that are shed. Whenever this method is relied on it should be borne in mind that the heads really increase in size between each moult, though not in proportion to the increase of body. Thus, in the present species the first head is considerably larger when shed than it was when the larva hatched, and though appearing uniformly black when hatched, it shows the usual white marks more or less distinctly when shed.

have been folded up and curled over and between the wrinkles of the body so as not to impede the casting of the skin. At Figure 64, *b*, I have given a somewhat enlarged view of a worm just in the act of casting its last skin in order to show (at *d*) how the flexible horns were folded. They unbend of their own accord, though the worm often helps to straighten them out by cunningly turning its head and drawing them over the surface of the leaf.

[Fig. 65.]



When full grown the worm presents the appearance of Figure 65, the colors being black, white and yellow.

HOW THE LARVA BECOMES A CHRYSALIS.

The metamorphoses of insects will ever prove a source of wonder and admiration. If a naturalist were to announce to the world the discovery of an animal which, for a short term of its life, existed in the form of a serpent; which then, after performing its own interment and weaving itself a shroud of pure silk, changed to something like an Egyptian mummy; and which after remaining thus buried without food or motion, for a much longer term, should at length struggle through its shroud and start into day a winged bird—every one would be interested in the history of such a marvelous creature! Yet the transformation of insects are scarcely less startling than such an occurrence would be, and it is only by drawing such a picture, that we are made to fully appreciate these changes. The methods of transformation are varied, as the reader who has perused these Reports is well aware. A good illustration is often needed in our schools, and as the present species furnishes an excellent illustration of the process in those butterflies which are suspended in the chrysalis state from the tail, and is withal so common that those who desire to witness the process will have no difficulty in doing so, I will give some account of it; for the person who had never witnessed the true method employed, might gaze a long time at the full grown larva (Fig. 65,) and the chrysalis (Fig. 67) without divining how the latter was produced by the former. We have on the one hand a crawling worm, and on the other a legless body hanging securely by

[Fig. 66.]*

*These figures are drawn from memory and are perhaps a little ideal and inaccurate.

its tail. What has become of the larval appurtenances and how did the chrysalis attach itself? Let us see.

As soon as the larva is full grown it spins a little tuft of silk to the underside of whatever object it may be resting upon, and after entangling the hooks of its hind legs in this silk, it lets go the hold of its other legs and hangs down with the head and anterior joints of the body curved as at Figure 66, *a*. In this position it hangs for about twenty-four hours, during which the fluids of the body naturally gravitate towards the up-turned joints, until the latter become so swollen that at last, by a little effort on the part of the larva, the skin bursts along the back behind the head. Through the rent thus made the anterior portion of the pupa is protruded and by constant stretching and contracting the larval skin is slipped and crowded backwards until there is but a small shriveled mass gathered around the tail (Fig. 56, *b*). Now comes the critical period—the culminating point.

The soft and supple chrysalis, yet showing the elongate larval form with distinct traces of its prolegs, hangs heavily from the shrunken skin. From this skin it is to be extricated and firmly attached to the silk outside. It has neither legs nor arms, and we should suppose that it would inevitably fall while endeavoring to accomplish this object. But the task is performed with the utmost surety, though appearing so perilous to us. The supple and contractile joints of the abdomen are made to subserve the purpose of legs, and by suddenly grasping the shrunken larval skin between the folds of two of these joints as with a pair of pincers, the chrysalis disengages the tip of its body and hangs for a moment suspended as at Figure 66, *c*. Then with a few earnest, vigorous, jerking movements it succeeds in sticking the horny point of its tail into the silk, and firmly fastening it by means of a rasp of minute claws with which that point is furnished. Sometimes severe effort is needed before the point is properly fastened, and the chrysalis frequently has to climb by stretching the two joints above those by which it is suspended, and clinging hold of the shriveled skin further up. The moment the point is fastened the chrysalis commences, by a series of violent jerkings, and whirlings to dislodge the larval skin, after which it rests from its efforts and gradually contracts and hardens until it presents the appearance of Figure 67. The really active work lasts but a few minutes, and the insect rarely fails to go through with it successfully. The chrysalis is a beautiful object and as it hangs pendant from some old fence board or from the underside of an Asclepias leaf, it reminds one of some large ear-drop; but though the jeweller could successfully imitate the form, he might well despair of ever reproducing the clear pale green, and the ivory black and golden marks which so characterize it.

[Fig. 67.]

This chrysalis state lasts but a short time, as is the case with all those which are known to suspend themselves nakedly by the tail.

At the end of about the tenth day the dark colors of the future butterfly begin to show through the delicate and transparent skin, and suddenly this skin bursts open near the head and the new-born butterfly gradually extricates itself, and, stretching forth its legs and clambering on to some surrounding object, allows its moist, thickened and contracted wings to hang listlessly from the body. Under the direct influence of the air, the circulation quickens so that the fluids of the body are driven into every portion of these wings, and they visibly expand under the eye, while the other parts of the body gain in strength and firmness. In less than an hour, and often within half an hour, the wings are ready to perform their intended work and our gay Archippus takes his first lesson in æronautics. Ah! what an enviable fellow is he,

> ———Lazily flying
> Over the flower-decked prairies, West;
> Basking in sunshine till day-light is dying,
> And resting all night on Asclepias' breast;
> Joyously dancing,
> Merrily prancing,
> Chasing his lady-love high in the air,
> Fluttering gaily,
> Frolicking daily,
> Free from anxiety, sorrow and care!

THE LARVA ENJOYS GREAT IMMUNITY FROM THE ATTACKS OF BIRDS AND OTHER PREDACEOUS ANIMALS.

Many of our insects, from one cause or another, enjoy a wonderful immunity from the attacks of predaceous and parasitic animals and there exists a curious relation between color and edibility. It is a very general rule that those which have such an immunity from the attacks of enemies, are conspicuously colored and feed openly upon the plants they attack; while those which are persecuted are generally of sombre and evasive colors, and often possess some protective resemblance to the objects upon which they occur, or hide themselves in one way or another. For several years past Mr. J. Jenner Weir, of London, England,—a gentleman whom I had the pleasure of meeting some eleven years ago—has made numerous experiments with the direct view of ascertaining what species of insects are eaten by birds and what species are rejected; and the results of these interesting experiments are recorded in the Transactions of the London Entomological Society (1869, pp. 21–26 and 1870 pp. 337–9). They point conclusively to the facts above given, and Mr. A. G. Butler of the British Museum made corroborating experiments, with, lizards, frogs and spiders. Prompted by these experiments made in England, I was led to make similar ones with our gaily colored Archippus larva, and the result fully accords with that obtained by Mr. Weir; for neither turkeys, chickens, toads or snakes would touch it. The reason why predaceous animals refuse these gaily colored larvæ is not always so easy to explain, but in the present case it is undoubtedly owing to an odor which the larva possesses. This odor is hardly appreciable, when the larvæ are in the open air; but by confining a few of them for a short time in a tight box, it soon becomes apparent, and is pungent and nauseous in the extreme even to our sense of smell, and it is doubtless more intensely so to the keener sense of birds and other animals.

Mr. A. R. Wallace believes that the gay colors of such larvæ are really protective, because if by more sombre colors they were undistinguishable from edible species, they would be seized by birds, and though rejected afterwards, would be so much injured that the probability of their producing butterflies would be very remote, even if they were not killed outright.

The same immunity is enjoyed by our Archippus butterfly in all its stages, and especially in the perfect state, in which the peculiar odor is still stronger, as I have abundantly proved.

The larva does not however enjoy entire immunity from parasites as has been hitherto supposed, for though after extensive experience I have never found any of the numerous Hymenopterous parasites attacking it, it is nevertheless often killed by a Dipterous Tachina-fly. I have never noticed any such parasite in the first brood of larvæ, but last year in the immediate vicinity of St. Louis, not one in fifty of the second brood escaped its fatal work; and this same parasite was by no means confined to one locality, as I received it from Mr. S. S. Rathvon, of Lancaster, Pa., who found the Archippus larvæ and chrysalids badly infested. The eggs of the Tachina-fly must be deposited for the most part while the larvæ are young, for specimens of larvæ taken at the first moult and confined in cages where no flies could get access to them, were frequently parasitised. These victimized larvæ usually succumb a day or two before they are full grown, though occasionally one succeeds in effecting the change to the chrysalis. They grow sickly and, hanging by the hind legs, become flaccid and discolored, while the parasitic maggots pierce the skin and fall to the ground, which they enter to transform. A silky liquid escapes from the breathing pores and from the holes made by these maggots, which, when dry, forms long white semi-elastic threads; and as the discolored larvæ hang by hundreds from the milkweeds, with these glistening filaments, one might at first imagine they had been smitten with some epidemic disease.

The Tachina maggot is not specially distinguishable from the many other larvæ of this kind which are known to infest the bodies of other insects, but the spiracles are encircled by a very distinct dark brown ring.*

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* The larva of this Tachina-fly, after it enters the ground, contracts very rapidly to the pupa state, and if retained on a hard surface, one may watch with interest how, as the chitinous covering thickens and hardens, the dark head is vigorously kept at work underneath it, gnawing or abrading the thickening skin in a constant circle, so as to partially sever that portion which serves as a lid to be easily pushed open by the future fly. I have often wondered how this lid in so many

Our Tachina-flies generally very closely resemble each other, and very little attention has been paid to them in this country. The present species seems to be new to science, but I forbear to describe it for the simple reason that it varies so much in itself and so closely resembles many others, that it would be next to impossible to characterize it sufficiently. It may be provisionally known, for purposes of reference, as the Archippus Tachina-fly—*Tachina* archippivora.* It may be at once distinguished from the two flies described in my second Report (p. 51), and which attack the true Army-worm, not only by the different form and smaller size, but by being of a paler gray, and by lacking the reddish or yellowish tail. The eyes are perfectly smooth. An interesting fact connected with this fly is that it likewise attacked the Fall Army-worm (as already mentioned on page 116, note,) which was so abundant at the same time of year. I have also bred it undescribed cut-worm.

The *Tachinariæ* can only be satisfactorily studied in connection with their habits, and even then they must prove a most difficult Division to work up. The species are very apt to grease in the cabinet and where they do not grease, the colors, especially of the face, lose their brilliancy. I am satisfied that the same species often attacks indifferently many widely distinct larvæ and that there are, in consequence, entomophagic varieties. I have a score of different lots, bred from as many distinct species of Lepidopterous and even Coleopterous larvæ; and the individuals of each lot, often bred from a solitary specimen of some particular species of larva, differ more among themselves than from individuals of some other lot, bred from a distinct species of larva. Indeed, unless there are striking characters, it would be folly for any but the specialist to attempt to describe them. These Tachina-flies, indeed, form such an extensive Division that in order to facilitate study, authors have inclined to erect genera upon characters most trivial and such as would certainly not be looked upon as of more than specific value in other groups. Sixteen specimens bred from *Danais archippus* vary from 0.18—0.30 inch in length and from 0.33—0.60 inch in expanse: some have a rufous spot on the side of the second abdominal joint, while others show no signs of any such spot. From among them two somewhat distinct forms occur in about equal numbers. In the one, which is on an average the largest, the abdomen is rather broader, and when dry shrinks so as to become flat, while the antennæ have the third joint from four to five times as long as the second. In the other the abdomen is rather narrower, remains more cylindrical when dry, and the antennæ have the third joint from five to six times as long as the second. These differences are, I believe, sufficient to cause the specialist to make distinct species or even genera; but as the same two forms occur in those bred from other species of larvæ, and as all the other

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coarctate pupæ was so regularly and smoothly opened by the nascent fly; but am now satisfied from observations made on this particular species, that it is previously prepared by the larva while contracting, in the manner described above. This will be more especially the case where the contracted skin is thick as in *Cuterebra*, *Œstrus*, etc., while in those where the skin is thin and delicate as in *Anthomyia* and many of the smaller *Muscidæ*, the habit probably does not obtain, as the fly can crowd itself out, and the opening is quite irregular, sometimes transverse, at others forming a simple longitudinal slit. I have witnessed the same wonderful forethought in the larva of *Chrysopa*, after spinning its small cocoon. In this case the sharp sickle-like jaws of the larva enable it to cut very finely and smoothly, and the edge of the severed parts show plainly, under the lens, a slight discoloration. The circle inscribed is often, but not always, slightly spiral so that when pushed open the lid hangs as on a hinge. The same habit no doubt prevails in the Lepidopterous genus *Limacodes* and its allies; for I have experimentally proved, by opening several cocoons of *Callochlora viridis*, Reakirt, both while the inmate was yet in the larva or pupa state, that the lid opens with the slightest pressure, and just as regularly as if pushed from within. There is, however, a marked difference in the working in these last two cases and that of our Dipterous larvæ. The former enclose themselves in cocoons, in which they have abundant room to turn round and partially cut their lid, while the Tachina larva performs the work on its own skin while it is hardening and before it has become separated from the transforming body within.

* I forwarded specimens of this fly to Dr. LeBaron, the State Entomologist of Illinois, who is better posted as to the minute generic differences between these flies, than any one else in the West, and he refers it to the genus *Masicera*, Macq., in speaking of which Macquart says: "they are the only *Tachinæ* which have the third joint of the antennæ very long without at the same time having the front very prominent." This and other minor genera of Macquart and Meigen have been discarded by some modern authors, such as Walker and Zetterstedt, and referred to *Tachina*.

details of structure, coloration, etc. are precisely similar, and as these differences themselves graduate, I cannot consider them specific. I have bred the same fly from larvæ of *Prodenia autumnalis* as stated above; also from larvæ of an undescribed Noctuan, closely resembling *Agrotis subgothica*, Haw. These specimens differ only in the rather smaller average size and more slender body, from specimens bred from several other distinct larvæ, and from the pupa of *Cynthia cardui*. It is also an interesting fact that the largest specimens of what appear to be but one species are those bred from the largest larvæ, as for instance that of *Citheronia regalis*.

THE BUTTERFLY OFTEN CONGREGATES IN IMMENSE SWARMS OR BEVIES.

Various butterflies have long been known in Europe, to swarm prodigiously at certain periods; but in this country no other butterfly congregates in such swarms as our Archippus, though the Painted Lady (*Cnythia cardui*), an insect found in all four quarters of the globe, and often seen in swarms in Europe, has been known also to swarm in Canada.

The Archippus butterfly appears in large bevies or flocks almost every year in some part or other of the West. In September, 1868, I received accounts of their sudden appearance in different parts of the city of Madison, Wisconsin, and at Manteno, Ills.; while on the 19th of that month Mr. P. B. Sibley of St. Joseph, Mo., sent me specimens with the statement that he saw millions of them filling the air to the height of three or four hundred feet, for several hours flying from north to south, and quite as numerous as the grasshoppers had been the year before.

In the spring of 1870 I received the following account of such a swarm from L. J. Stroop of Waxahachie, Ellis Co., Texas:

During my ramble this morning (March 31st) I happened upon a flock or bevy of butterflies known as *Danais archippus*, Fabr., containing thirty individuals, four of which I captured for the purpose of identification, only two of which, however, I pinned down. I find them to be of the genuine *archippus*, identical in every respect with specimens bred from the caterpillar by myself last summer, except in that of color, which is somewhat paler in these captured this morning than it was in those bred by me in the summer. They have the appearance of having been on the wing some days.

A little later the same spring similar swarms were noticed in different parts of Kansas, the most remarkable of which was one which occurred at Manhattan about the middle of April, and which, as I learn from Mr. Thos. Wells of that place, came rapidly with a strong wind from the N. W. and filled the atmosphere all around for more than an hour, sometimes so as to eclipse the light. Again, large flocks passed over the same place in a southerly direction, on the evening of the 27th and morning of the 28th September, while at Alton, Illinois, great numbers of them were seen passing in a S. W. direction on the last day of October of the same year.

It would be difficult to give any satisfactory reason for this assembling together of such immense swarms of butterflies. Insects otherwise solitary in their habits sometimes congregate thus for purposes of emigration; but this can hardly be the object of our butterfly bevies. They certainly do not travel very long distances or we should hear more numerous accounts of them. There are two significant facts connected with them from which some corollary might be deduced, namely, that only those species which have a very extended range are known to form such flocks, and that they always travel, under these conditions, in a southerly or south-westerly direction. Mr. Bates* gives an interesting account of the uninterrupted processions of butterflies belonging to the genus *Callidryas*, which passed from morning to night in a southerly direction across the Amazons; and as far as he could ascertain these migrating hordes were composed entirely of males.

If our Archippus flocks should turn out to be all males, this fact may lead to some solution of the cause of their congregating; but I incline to believe the flocks are composed of both sexes. Again, if the swarms occurred during the egg-depositing season, we might even then venture to solve the problem. For it is evident that a species which enjoys such immunity from predaceous animals and which is confined in its diet to a single family of plants, must occasionally multiply in particular districts beyond the capability of the plants to sustain them; and as most female butterflies instinctively refuse to deposit eggs on a plant that has already been abundantly supplied by some other individual, the females of our Archippus would naturally roam in vain for fresh plants when once the latter had all been stocked; and would thus congregate together, and, followed by the males, form migrating bevies. Or we might suppose that after the larvæ had eaten up all the milk-weeds in a district, the butterflies they produced, finding no plants upon which to lay their eggs, would be forced to migrate in swarms. But neither of these suppositions can have much weight from the fact that the swarms occur either late in the fall or early in spring; and the most plausible solution under the circumstances is that, as these are the seasons when the milk-weeds are either destroyed or have not yet started to grow, the butterflies, having nothing to confine their attention and keep them isolated, naturally congregate together, and that when in motion, the low temperature of the seasons instinctively prompts them to wend their way southwards. The probabilities are that these swarms are eventually destroyed, for no species can multiply beyond a certain limit, and when there is not check to increase in one direction, there will be in another. Of course this is as yet all theory and hypothesis, but hypotheses in such cases are necessary, for they are threads on which to string and combine the known parts of a case so as ultimately to arrive at the real truth in the matter.

* Naturalist on the River Amazons, I, p. 249.

THE DISIPPUS BUTTERFLY—*Limenitis disippus*, Godt.

(Lepidoptera, Nymphalidæ).

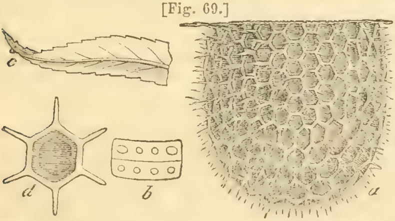
This is another butterfly (Fig. 68) which is well known in the Mississippi Valley. It belongs to a family which agrees with that to which the previous insect belongs, in the front pair of legs being more or less functionally impotent, but differs remarkably from it in the large cell in the centre of each wing never being closed externally by a distinct tubular vein, and in its being generally open towards the outer margin of the wing: also in lacking the small nervule at the base of the front wing, spoken of on page 143.

[Fig. 68.]

The food-plants of the Disippus butterfly are Willow, Poplar and Plum, and though not as numerous as the Archippus, it is yet tolerably common in the Mississippi Valley and occurs sparingly all over the United States and in the West Indies. As will be seen by referring to the figure*, though belonging to an entirely distinct family, it nevertheless bears a great general resemblance to the Archippus butterfly, and this resemblance is rendered more striking by the colors of the two insects being identically the same.

The natural history of this species is fully as interesting as that of the Archippus butterfly—if not more so. The egg which, so far as I am aware, has never before been described and figured, differs remarkably from that of the Archippus butterfly and is well represented at Figure 69, *a* showing it greatly magnified, *c* of the natural size and *d* giving a greatly magnified view of one of the cells with the filamentous processes from each angle of the hexagon. The color is at first pale yellow but soon becomes gray as the embryo within develops. It is usually deposited singly near the tip of the leaf, generally on the underside but often on the upper side; and I have exceptionally found as many as three together, and sometimes one on either side of the leaf, opposed to each other.

[Fig. 69.]

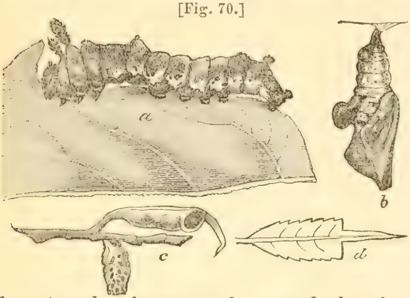


* In Figure 68, which represents the Disippus butterfly, the left wings represent the upper surface, and the right wings, which are detached from the body, represent the lower surface. The difference in the coloration of the two surfaces is but slight in this species, neither does it amount to much in the Archippus butterfly; but in some butterflies and in others belonging to the same genus, it is very considerable.

DESCRIPTION OF THE EGG.—Length 0.38 inch. Diameter at base about the same. Globular, with the top often slightly depressed. Hexagonally reticulate, the cells more or less regular, sunken so as to give the egg a thimble-like, pitted appearance, and about 10 of them in the longitudinal row and 30 in the circumference. Covered with translucent filamentous spines, one arising from every reticulate angle and giving the egg a pubescent appearance. Each spine about as long as the cell is wide, those on the top being longest.

The young larva differs materially from its more mature self, as will be seen from the description which follows. It grows apace, casting off its old coat and devouring the same three times during its growth, and eventually suspending itself by the hind legs and transforming to the chrysalis, frequently within a month from the time of hatching. The mature larva (Fig. 70, *a*) presents a roughened tubercled appearance and varies much in color, the predominan colors being moss-green, brown and creamy-white; the moss-green parts being studded with beautiful light blue points. The pupa Fig. 70, *b*) is marked with burnt-umber brown, ash-gray, flesh-color and silvery white, and is characterized like that of the other species of the genus, by a curious thin almost circular projection which has been likened to a Roman nose, growing out of the middle of its back.

[Fig. 70.]



DESCRIPTION OF MATURE LARVA.—Length 1.20, diameter 0.25 inch. General color either whitish or olive-green. Body thickly granulated. Head dull olive, with dense minute prickles; its vertex bifid and terminating in a pair of prickly cylindrical horns, transversely arranged and each about 0.03 inch long. Back speckled and mottled with olive of different shades above the line of the spiracles, except joints 2 and 8 and the upper part of 7 and 9, but with a continuous pure white line below the spiracles, beneath which white line on joints 4–10 is a large olive patch extending on joints 6–9 to the external tip of the prolegs. A pair of black transversely-arranged dorsal dots in the suture behind joint 2, and a more or less obvious lateral one just above and behind the 5th and 7th pair of stigmata surmounting the lateral white line. Joints 3–7 and 9–11 with more or less, shining, elevated, blue dots. On joint 2 a pair of prickly cylindrical black horns, transversely arranged and 0.16 inch long. On joints 3, 10 and 11 a pair of large dorsal tubercles transversely arranged, each crowned by a little bunch of 8–12 robust prickles. On joint 5 a pair of similar tubercles, but still larger, of a yellowish color, and mamma-like. On joints 4, 6, 7 and 9 tubercles similar to those on joints 3, 10 and 11, but smaller. On joint 12 four black prickly dorsal horns, quadrangularly arranged and each about 0.03 inch long. Stigmata and legs blackish.

Described from many specimens. Such are the prominent and more constant traits of this larva, but it is so variable in the general depth of coloring and in the proportion of the lighter and darker shades that it is next to impossible to frame a description which shall alike agree with half a dozen specimens.

The newly hatched larva presents a quite different appearance. It is 0.09 inch long with a yellowish-brown head twice as large as the first joint and distinctly bilobed. The first joint is also larger than the others. Each joint is divided by a transverse impressed line, and upon the dorsum of each fold thus made are 4 pale elevated spots, the anterior outer ones larger than the rest, as shown at Fig. 69, *b*, especially on joints 2, 3, 5 and 11 where they appear conical with a darker annulation at base. There is a subdorsal and a sub-stigmatal row of similar rounded warts, and they all give rise to little pale bristles or spines. The general color is pale yellowish-brown, mottled with dark streaks, especially below the stigmata. The second period scarcely differs from the first except in the somewhat greater length of the horns. In the third period the horns acquire their mature proportions, and the whole larva becomes more granulated. In the fourth or last the blue points appear and the lateral rows of tubercles lose their conspicuousness to a great extent.

ITS WINTER QUARTERS.

One of the most interesting features in the life-history of our Disippus butterfly is its mode of hibernating. A great many moth larvæ pass the winter in the larva state sheltered in one way or another; but no other American butterfly has hitherto been recorded as hibernating in this state, except the closely related Ursula butterfly,* though no doubt the few other species belonging to the same genus possess a similar habit. Misled, perhaps, by the fact that the butterfly is seen flying about so early in the spring that it could not have had sufficient time to hatch out from the egg and acquire its full larval growth the same season, and with its wings so bright and unworn that it could not have hibernated as a butterfly as some other closely allied species are known to do; Dr. Harris, in his work on Injurious Insects (p. 282) asserts that it hibernates in the pupa state, though he subsequently, in the year 1850, became aware of the facts in the case.†

In reality the larvæ of the autumnal brood, when about one-fourth or one-third grown, build for themselves curious little houses (Fig. 70, *c*), in which they pass the winter. First and foremost—with wise forethought, and being well aware through its natural instincts, that the leaf which it has selected for its house will fall to the ground when the cold weather sets in, unless it takes measures to prevent this—the larva fastens the stem of the leaf with silken cables securely to the twig from which it grows. It then gnaws off the blade of the leaf at its tip end, leaving little else but the mid-rib, as shown in Figure 70, *d*. Finally, it rolls the remaining part of the blade of the leaf into a cylinder, sewing the edges together with silk.‡ The basal portion of the cylinder is of course tapered to a point, as the edges of the leaf are merely drawn together, not overlapped; and invariably the lower side of the leaf forms the outside of the house, so as to have its projecting mid-rib out of the way of the larva, as it reposes snugly in the inside. The whole when finished (Fig. 70, *c*) has somewhat the appearance of the leaf of a miniature pitcher-plant (*Sarracenia*), its length being 0.50–0.65 inch, and its diameter 0.11–0.14 inch.

*There is good reason to believe, however, that some of those butterfly larvæ which habitually protect themselves by a sort of loose cocoon, made by drawing together or rolling up the leaves of their food-plant; likewise pass the winter in the larval state. At least I have known an oak-feeding larva of *Nisoniades juvenalis*, Sm. and Abb., kept by a lady friend of mine, to remain in the larva state nearly all winter before transforming to the chrysalis. But there is not strict analogy between such a case and that of the hibernation of the immature *Disippus*.

† *Harris Correspondence*, p. 245.

‡ In the article in the *Am. Entomologist*—which was the greater part of it written by Mr. Walsh, with my own facts and experience inserted here and there—it is stated that the "gnawed portion of the leaf forming the flap, is bent down and fastened by silken cords, so as to act as a door to the house." After fuller experience, I find that this is very seldom the case, but that the orifice is more often left open.

These curious little cases may be commonly found upon our willows or poplars in the winter time. I have examined hundreds of them, and although they are invariably built upon the same plan, they vary greatly in the degree of perfection which the architect attained; and this is especially the case when they have been built in confinement. The blade on the tip piece is sometimes gnawed off right down to the rib; at others it is left almost as broad as the tube. Sometimes it is bent over the orifice; at others not. They are also much more irregular and ungainly when made from broad leaves such as those of the Silver poplar, than when made from the more narrow leaves of the Willow. These autumnal larvæ have also another peculiar habit not heretofore recorded, and which was first pointed out to me by Mr. J. A. Lintner, of Albany, N. Y. They exhibit a tendency to build from the time they are born, and will always eat the leaves from the side, gnawing large holes and cutting along the sides of the mid-rib, as at Fgure 71, *a*. They commence at the tip and as they work downwards towards the base, they collect the debris into a little bunch, which they fasten with silk to the mid-rib. When the hibernaculum is finished the seam is perfectly smooth and the whole inside is lined with silk. The larva, after completing its work, composes itself for the winter, with the tail towards the orifice. Here it remains till the catkins are in bloom the next spring, when it retreats from its house and commences feeding. Not the least wonderful part of the phenomenon is, that it is only the autumnal brood of larvæ that form pitcher-like houses to live in during the inclement season of the year, the summer brood having no occasion to shelter themselves from the cold. We thus have an instance of a curious architectural instinct being only developed in alternate generations; which is much the same thing as if, with a certain race of men, the great-grandfathers, the fathers and the grandchildren ran wild in the woods, and the grandfathers, the sons and the great-grandchildren lived in houses and led the life of civilized human beings.

[Fig. 71.]

When we duly consider this peculiarity in our Disippus larva, we may well pause and ask—

> What wondrous power enables it so well,
> The coming cold of winter to foretell,
> And to provide for its long torpid rest,
> A house, from means at hand, the very best?

We can but admire the beautiful adaptation of means to an end—no matter how we choose to explain it! There can be little doubt but that many of the phenomena in animal life which we so summarily dispose of by the ready use of that rather blind term "instinct," might be explained in a more natural way. The term is justly applied to those actions which are prompted by exterior influences or peculiarity of organization, and which are performed unconsciously; but by its too general application, most people have acquired a deep-set idea that all animals act under its power, and have nothing akin to our reason; whereas there is hardly anything more certain than that true reason of degree exists very generally in the animal kingdom; or that what we know as pure instinct may have been developed by natural law, *i. e.*, first acquired by experience and afterwards fixed as a habit by heredity.

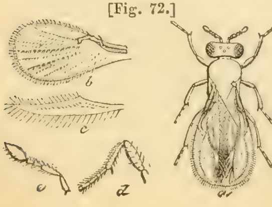
The subtle influences of the late fall which seem to convey through every pulse of nature, intelligence of the approaching winter, and which cause all animals to prepare for their hyperborean sleep, no doubt originally induced the young larva of the ancestral type from which our Disippus and the other species of the genus sprung, to prepare for itself some shelter. The gradually increasing cold and the decrease of nourishment in the leaf, would act as physical prompters, and the pitcher-like house, which at first strikes us as so remarkable, is the simplest structure that could be made with the materials at command. The characteristic smoothness of its food-plant—forbidding as it does the shelter under loose bark which many larvæ seek—would also tend to develop such a trait. That this trait—this instinct—should only be developed under similar conditions to those which gave birth to it, is not so remarkable; and that it does only so develop, seems certain, for I have every reason to believe that while the insect is two-brooded further north, it is sometimes three-brooded with us, and consequently that this peculiar instinct obtains either in the second or third generation, according to circumstances.

ITS PARASITES.

Though not generally known to entomologists, our Disippus butterfly is very subject to the attacks of parasites, at least three distinct species infesting it in the preparatory states. One of these is a *Tachina*-fly, of which I have often noticed the eggs fastened transversely on the back of the neck of the larva, but of which I have not obtained the fly. In all probability it does not destroy the larva till the latter is nearly full grown. The other two I will briefly describe as no mention has heretofore been made of them.

THE DISIPPUS EGG-PARASITE.—The eggs already described were

[Fig. 72.]

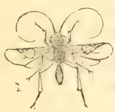


very abundant last fall on a certain clump of willows near Kirkwood, and of about two hundred obtained, fully one-half of them were parasitised. Instead of hatching out into larvæ, as they would have done if they had been unmolested, these last produced little dark colored four-winged flies, from four to six of which would gnaw their way through the shell of each egg. This little fly belongs to the great *Chalcis* family, and though scarcely more than 0.02 inch long, it can jump to the distance of several inches. Its wings, especially the hind ones, are beautifully fringed with hairs. It is inconspicuously marked, the body being dark brown with the antennæ and legs pale, and the wings iridescent. The highly magnified outlines at Figure 72 will convey a good idea of its appearance, *a* showing the fly with wings folded on the back, *b* one of the front wings, *c* one of the hind wings, *d* one of the legs, and *e* one of the antennæ.

I shall leave the proper determination of this insect to those who pay more particular attention to the CHALCIDIDÆ. It comes nearest the genus *Trichogramma*, Westw., and may be provisionally called *Trichogramma* (?) *minuta.* It differs from that genus and from all other Chalcididan genera with which I am acquainted, in the antennæ being but 5-jointed (scape, plus 4 joints), the scape stout and as long, or longer, than joints 2, 3 and 4 together; joints 3 and 4 small and together as long as joint 2; 5 very stout, fusiform and as long as 2, 3 and 4 together. The legs have the trochanters stout and long, the tibiæ not quite so long nor so stout as the femora, and with a long tooth; the tarsi are 3-jointed, with the joints of equal length and with the claws and pulvilli subobsolete. The abdomen is apparently 6-jointed, the basal joint wide, the 2nd narrower, 2—5 increasing in width till 5 is as wide as 1. The ovipositor of ♀ extends a little beyond the apex, and starts from the anterior edge of the 5th joint.

THE DISIPPUS MICROGASTER.—The third parasite which also very commonly infests the last brood of larvæ, and kills its victim during the second period, is a little black four-winged fly belonging to the genus *Microgaster.* The parasitic maggot eats its way out just before the Disippus larva gets ready to build its winter tenement, and spins a pale yellowish cocoon of silk, either upon the back of its victim or upon the leaf close by; and from this cocoon the fly soon afterwards issues. Figure 73, which represents the Army-worm *Microgaster* enlarged, will convey a good idea of its Disippus relative.

[Fig. 73.]



The genus *Microgaster* is a very extensive one, and the species have not yet been well studied in this country. They are all of small size, and in many instances resemble each other so closely that they can only be satisfactorily studied in connection with their habits and the particular larvæ which they infest. Some appear to confine their attacks to one particular kind of caterpillar, while others infest alike many different species. Thus the one under consideration not only infests the Disippus larva, but I have also bred it from that of the Golden-rod Gall-moth (*Gelechia gallæsolidaginis*, Riley) obtained from Canada; which indicates it to be a widely distributed species.

MICROGASTER LIMENITIDOS, N. Sp.—♂ ♀. Length 0.09 inch. Color pitchy-black. Antennæ black, about as long as body; palpi whitish. *Thorax* minutely punctured. *Abdomen* with the two or three basal joints emarginate and rugose, the terminal joints smooth and polished. *Legs* dusky; front and middle femora yellowish, hind femora black; front and middle tibiæ yellowish, hind tibiæ with terminal half dusky, but the spur pale; front and middle tarsi yellowish tipped w[illegible]h dusky, hind tarsi dusky above, paler below. *Wings* hyaline, iridescent, the nervures and sti[illegible]a black or dark-brown, the radial nervule, the cubital nervules and the exterior nervule of the [illegible]s coidal cell, sub-obsolete.

Described from 6 ♀, 1 ♂, bred from larvæ of *Limenitis disippus,* 3 ♀ bred from larvæ of *Gelechia gallæsolidaginis.* In the latter the nervures of wings are paler and less distinct than in the former. Most of our N. A. species of this genus have been described by Mr. Cresson who has seen this and considers it new. It certainly differs from the other described species.

MIMICRY AS ILLUSTRATED BY THESE TWO BUTTERFLIES, WITH SOME REMARKS ON THE THEORY OF NATURAL SELECTION.

The means by which animals are enabled to escape from their enemies and obtain their food, or in other words to sustain themselves in the great struggle for existence that is continually going on between each species, are as varied as they are wonderful. There is generally a conformity of tint between all animals and their surrounding, and in the higher classes Mr. A. R. Wallace has shown* that in general terms it may be stated that desert animals are desert colored, arctic animals white, and nocturnal animals gray, *i. e.*, of such colors as best to accord with the surroundings. Animals, birds, fishes and reptiles come under this rule to a great extent, and the reader will be amply rewarded by perusing the details given in the valuable and interesting work referred to. But in no Class of animals does this principle of adaptation to environment occur so generally and in such a striking manner as in insects. With them mimicry and other protective resemblances are almost universal, and it may be given as a rule that all insects living above ground, when not naturally protected by odor, luminosity or defensive covering such as hairs, spines, hard shelly wings, etc., or by armor such as stings, beaks, etc., either cover themselves with one substance or another, or similate their surroundings, or mimic either other animals, plants, or even inorganic substances. With insects in their larval states, will this rule especially hold good.

What entomologist has not been deceived by the close resemblance of the beetles belonging to the genus *Chlamys* to the dung of caterpillars; or is not familiar with the quaint and close resemblance of the Walking-sticks and Walking-leaves to the objects from which they take their names? Chapter after chapter might be written on these wonderful imitations which deceive the best trained eyes; and there are many most striking instances among our American insects which have never yet been published and which I hope some day to illustrate. But my present purpose is simply to draw attention to the illustration afforded by the two butterflies which we have been considering.

These striking resemblances were formerly looked upon, for the most part, as curious analogies in nature, intended to carry out the

*Contributions to the Theory of Natural Selection.

general plan of the Creator; but viewed in the light of modern science, and especially by that of the Darwinian development hypothesis, they have acquired an immense significance. One of the most interesting phases of this mimicry, and one which has only within the last few years been brought to light, is the imitation by an otherwise defenseless butterfly, of one whose great numbers and wide distribution indicate that it enjoys peculiar advantages. This specific imitation of one butterfly by another is precisely of the same nature as the mimicking of a vegetable or inorganic substance, and may consequently be just as properly termed mimicry. Some authors seem to make a distinction between this so-called mimicry and what is known as "protective resemblance," while others again misconceive the true import of the word "mimicry" as used in this connection. Thus, Maj. J. R. Muhleman in an essay on "Mimicry in Insects," read before the Central Illinois Horticultural Society this winter, gave the word so broad an interpretation as to apply it to the possum-playing of some insects, and even to the supposed and far-fetched resemblances such as that of the female Canker-worm to a plant-louse, and of the female Bag-worm to a Dipterous maggot. True mimicry can only occur where it is of benefit to the species, no matter whether the benefit be derived by enabling harmless species to avoid their enemies in one way or another; or by enabling predaceous species to deceive their prey by assimilating the form and colors of the latter.

As already stated, the particular group to which our Archippus butterfly belongs is a large one, and the species comprising it are very numerous. They are especially abundant in South America, and like our own species, they all possess a pungent odor which seems to pervade all the juices of their system. So much is this the case that according to Mr. Wallace,* when an entomologist "squeezes the breast of one of them between his fingers to kill it, a yellow liquid exudes which stains the skin, and the smell of which can only be got rid of by time and repeated washings." The wings of these butterflies, as may be seen by referring to Figure 63, are rather longer than usual, but their flight is comparatively slow, and they do not dodge and zig-zag about with sudden skips and jerks as the "Skippers," (HESPERIDÆ,) are known to do. They furthermore possess no adaptive coloring to protect them during repose, for they take no pains to hide themselves, and their colors are bright, and those of the underside as conspicuous as those of the upper.

Hence we cannot assume that they are enabled, by their peculiar mode of flying, to escape to a great extent those cannibal animals that would otherwise catch and devour them; and if we propose to account for their prodigious abundance at all, we are driven to have recourse to some other hypothesis. Indeed, so far is it from being the case that it is their mode of flight which enables them to

*Contributions, etc., p. 78.

escape from their cannibal foes, that Mr. H. W. Bates, the English naturalist, who spent eleven years in the Valley of the Amazon River, studying the natural history of the insects of that region, where this particular group of butterflies is very copiously represented, declares that he never saw a single one of them attacked by any cannibal foe whatever, whether bird, or Dragon-fly, or lizard, or *Asilus*-fly.

It is therefore reasonable to assume that their peculiar odor renders them unpalatable to animals of prey. We have seen that the Archippus butterfly enjoys an almost perfect immunity from the attacks of predaceous animals, consequent, in all probability, upon this peculiar odor which attaches to it both in the larval and perfect states. In this case the supposition is even strengthened by the fact that the only parasite known to attack it is a *Tachina*-fly, belonging to a family which is notoriously defiant of strong odors, the larvæ often rioting in filth and the flies many of them known to be especially attracted to such odors.

Now there is another large group of butterflies, known as the *Pieris* family, to which the white cabbage butterflies belong, which were mentioned in my last Report (pp. 104–110.) This group differs widely in structure from the *Danais* group, and is represented by many species in the Valley of the Amazons; but instead of the species being exceedingly abundant in individuals, as in the case of those belonging to the *Danais* family, it is quite the contrary; the proportion between the number of individuals belonging respectively to two of the commonest genera of either group (*Leptalis* and *Ithomia*) being only 1 to 1000. Hence, it is reasonable to infer that this group must be much persecuted by cannibal foes, and such has been found to be the case.*

The colors found in the species of the *Danais* family are red, yellow, orange, white and black; while only the last two colors obtain in the *Pieris* family, the white being sometimes tinged with greenish yellow. So far so good. We see flitting about in the great Valley of the Amazons, vast swarms of long-winged butterflies, gorgeously dressed in red, orange, yellow, white and black; and certain short-winged butterflies, in very much smaller numbers, whose proper livery is but the plain black and white that befits a funeral. We see the former enjoy an entire immunity from the attacks of all predaceous animals, and the latter snapped up by every hungry bird, Dragon-fly or *Asilus*-fly that happens to come across them. Will it be believed, now, that there are certain particular species of the homely, much persecuted, short-winged group, that assume the livery worn by certain particular species of their gaily dressed compatriots, and actually even copy their elongated wings? Yet such is the indubitable fact. In the Memoir of Mr. Bates, already referred to, will be found

*These facts were first brought to light about nine years ago, by Mr. Bates, in a most interesting and valuable Memoir, published in the Transactions of the Linnæan Society, (Vol. XXIII, p. 495.)

beautiful colored figures, in the highest style of art, both of the species that mimic and of those that are mimicked; and no one that looks at those figures with an unprejudiced eye can believe for a moment that the resemblance is merely accidental.

Even the practiced eye of the entomologist is sometimes deceived by these close resemblances, and to illustrate, I cannot do better than to quote Mr. Bates's own language:

These imitative resemblances, of which hundreds of instances could be cited, are full of interest, and fill us with the greater astonishment the closer we investigate them; for some show a minute and palpably intentional likeness which is perfectly staggering. I have found that those features of the portrait are most attended to by nature, which produce the most effective deception when the insects are seen in nature. The faithfulness of the resemblance, in many cases, is not so striking when they are seen in the cabinet. Although I had daily practice in insect-collecting for many years, and was always on my guard, I was constantly deceived by them when in the woods. (p. 507).

Mr. Bates accounts for these singular cases of mimicry by supposing that, ages and ages ago, certain individuals of this plainly-dressed and much-persecuted *Pieris* family happened to vary slightly so as to resemble slightly some species or other belonging to the gaily-dressed and unpalatable *Danais* family; that, in consequence of this slight resemblance, they were sometimes mistaken for their more fortunate compatriots by cannibal animals, which would otherwise have preyed upon them forthwith; and consequently that they survived long enough to propagate their species, while almost all the individuals that had not varied in this particular manner perished prematurely by a violent death. Now, we know that, in the language of breeders and stock-raisers, "like produces like," which is what naturalists express by the well-known term of the "Law of Inheritance." Hence the descendents of this primordial race of imitative butterflies would naturally, most of them, vary in the same manner as did their ancestors from the normal type; and some of them would probably vary in a still more marked manner and in the same direction. These last individuals, as they would bear a still closer resemblance to the unpalatable butterflies, would of course stand a still better chance of surviving and propagating their species, in the course of that great Struggle for Existence, which we see going on all around us, not only among the inferior animals, but among the human species itself. By the perpetual repetition of this process, during indefinite ages, that perfect imitation of the imitated butterfly would at length be formed, which at first view appears so utterly inexplicable. And when it had once been formed, the very same process that originally formed it would afterwards keep it up to the standard of perfection. For all individuals, that varied in a backward direction towards the primordial type, would be more liable than the rest to be devoured in early life by cannibals, and would therefore be less likely than the rest to propagate their own image in succeeding generations. The whole process, indeed, is so beautifully simple and intelligible, that, but for certain prepossessions and prejudices, it would at once command the assent of every logical mind. In fact, it is strictly analogous to the common operation of "rogueing" a bed of seedlings, which every gardener is familiar with. The only difference is that, when the gardener pulls up what he calls the "rogues" out of a thousand seedling tulips, *i. e.*, those which deviate from the standard of perfection which he is aiming to attain, he acts with the definite object of preventing the further propagation of those so-called "rogues;" whereas, when cannibal animals destroy the "rogues" among the imitative butterflies, they are of course perfectly ignorant of the consequences likely to follow, and act wholly and solely for the gratification of their own carnal appetites. In short, the whole phenomenon is explained on the theory of Natural Selection as expounded by Darwin.

Since the publication of Mr. Bates's paper, a great many additional cases of similar mimicry among butterflies have been observed by Mr. Wallace* in the Malayan region of South America, and by Mr. Trimen in South Africa.† But though most of these wonderful cases of mimicry occur in the tropics, where insect development is so rapid and species are so abundant, we also have a striking instance of similar mimicry in our two N. A. butterflies, *Archippus* and *Disippus*. The resemblance between them must long ago have been noticed, for it is so servile that Prof. Jaeger in his *Life of North American Insects*, has actually favored his readers with a figure of the Disippus and gravely informs them that it is the Archippus butterfly. Indeed it is far more striking than my figures would indicate, and in a state of nature the two insects could hardly be distinguished at a short distance by the sharpest eyes. The fact that these two species offer an illustration of similar mimicry to that observed so frequently in the tropics, was first made clear by Mr. Walsh and myself in the *American Entomologist* for June, 1869; and the facts which have since come to my knowledge all tend to confirm the opinion.

The only other species belonging to the same genus as our Disippus butterfly, which occurs in the Mississippi Valley, is the Ursula butterfly‡ (*Limenitis ursula*, Fabr.), an insect which differs remarkably from our Disippus in being of a sombre blue-black color, with its wings bordered both above and below with blue, and below with a series of dull orange spots inside the blue border. Its larva feeds on Willow, Scrub-oak, Whortleberry, Cherry and Plum, and as already stated, has the same habits as that of Disippus, which it resembles so closely as scarcely to be distinguishable. The pupæ of the two species are also undistinguishable.

* See the Chapter on Mimicry among Lepidoptera in his Contributions, etc.

† See his paper on "Mimetic Analogies among African Butterflies," in the Transactions of the Linnæan Society for 1868.

‡ There are seven described species of N. A. *Limenitis*, but with the exception of the two above named they are all confined to the more eastern or western portions of the Continent.

If this Ursula butterfly were placed side by side with the Archippus butterfly, everybody would say at once that no two species could possibly be more unlike in the general style of their coloration. Clearly, therefore, it cannot be considered as in any wise mimicking the latter. Now, the Ursula butterfly is found everywhere throughout the Northern States wherever the Disippus butterfly is met with; and yet, while the latter is a common and abundant species, the former is quite rare. This is certainly the case in the Mississippi Valley, and will, according to my own experience, and that of others* very generally hold true all over the country.

To what are we to attribute this fact? It can scarcely be owing to structural differences in the external organization of the two species; for the two belong to one and the same genus. It surely cannot be because the larvæ of the former are more exposed to the attacks of predaceous animals than those of the latter; for they inhabit the same, or very nearly the same trees, and in size, shape and general coloration the two are almost exactly alike. Certainly it can not be because the pupæ of one species are more subject to be devoured by birds, insects, etc., than those of the other species; for it is impossible to tell one pupa from another when placed side by side. The only cause to which we can reasonably attribute the great abundance of the Disippus butterfly and the comparative rarity of the Ursula butterfly is, that the former mimicks the Archippus butterfly, as has been shown above, and is consequently often mistaken by birds, tree-frogs, Dragon-flies, *Asilus*-flies and other beasts of prey for its unsavory prototype and allowed to escape with impunity, while the latter, having no such disguise, is ruthlessly devoured by every insect-eating animal that can get hold of it.

All the facts lead to such a conclusion. The mimicked species enjoys an almost perfect immunity from the attacks of enemies in all its stages, while the mimicker is persecuted by several. The mimicker is often found in company with the mimicked, as I have myself, and as others have witnessed.† But what is still more conclusive is the fact observed by Mr. S. H. Scudder‡ that in the extreme Southern States where the Disippus butterfly occurs, and Archippus is replaced

* According to Mr. J. A. Lintner, *Ursula* is "rare" and *Disippus* is found abundantly in New York. (*Proc. Ent. Soc. Phil.*, III., pp. 63–4.) According to Mr. J. Kirkpatrick *Ursula* is "rather rare" and *Disippus* "common in the fall" in Ohio. (*Ibid.*, p. 329.) According to Mr. Sam H. Scudder, *Ursula* is "rather rare" and *Disippus* is "common" in New England. (*Proc. Essex Inst.*, III., p. 165.) According to Mr. Billings, who does not seem to have met with any *Ursula* at all, *Disippus* is "very common from July to October" in Canada West. (*Canad. Entom.*, I., p. 45.) There appear to be some exceptions to this rule, however, for Mr. Thos. W Higginson, of Newport, R. I., declares (*Am. Entomologist*, II., p. 177.) that *Ursula* is one of the commonest of the large butterflies there and decidedly more so than *Disippus*. I was also informed while at Troy last fall, that the former outnumbered the latter in the vicinity of New York City in the year 1868, though the previous years it had been quite rare. These exceptions to the rule may be owing to one cause or another, but I shall attempt to explain them when I come to consider the objections to the theory which I espouse.

† Mrs. Mary Treat, of Vineland, N. J., writes that *Archippus* was unusually abundant there last fall, and that she found *Disippus* in company with it.

‡ *Nature*, Vol. III, p. 147.

by the Berenice butterfly—a species of the same genus and of similar appearance but of darker color—the color of the mimetic Disippus deepens nearly or quite to the tint of the Southern *Danais*. Thus it is that facts before unintelligible are explained by Darwinism!

In a discussion on the difficulties of Natural Selection, which took place in late numbers of the London journal *Nature*, some ingenious objections have been urged. As many of them have especial reference to the mimicry we have been noticing, a brief summary of these objections will prove interesting in this connection, the more especially as all objections must in the end only serve to strengthen a theory, if that theory is sound.

Mr. Alfred W. Bennett* undertakes to show upon mathematical considerations, that Natural Selection could not produce these mimetic forms. He assumes that it would take 1000 steps to enable the normal form of a *Leptalis* for instance, to pass into the protective form of an *Ithomia*; that no change less than one-fiftieth of the whole alteration—*i. e.* 20 steps—would be of any use to the insect, and that the alterations in the early stages, being useless to the animal, would not be preserved, and even if they were, could not be attributed to Natural Selection, but to an accumulation of chances. He reiterates what has already been well shown and acknowledged by Darwinians, namely, that Natural Selection cannot produce the first change, and asks with good reason why the same principle that works the first change should not also work the subsequent changes? He does not dispute the secondary power of Natural Selection, but believes in an unconscious organizing intelligence which co-operates with it to produce the mimetic results. He endeavors to strengthen his position by showing that there is a close connection between instinct and mimicry, and ventures the theory that "the power of mimetism, so far as is known at present, runs almost *pari passu* with the development of the nervous system."

The essay is an able and interesting one, and the arguments are skillful and ingenious. It pays due and just respect to Darwinism and forcibly presents the fact, which no one has denied, that some other power than natural selection acts in producing first change The mathematical argument, however, will have little weight with those who fully appreciate the changes in Lepidoptera that take place in nature. No entomologist who has had any experience in rearing Lepidoptera will admit with Mr. Bennett that 1000 steps are necessary to produce mimetic resemblance, and when this foundation stone of his objection is taken away, much of his other reasoning which is built upon it becomes weak. Instances of great and sudden variation among butterflies and more particularly among moths are by

* *Nature*, Vol. III, pp. 30–33.

no means rare. In this Report instances of great variation in species have been given, and hundreds of others might be cited.*

Mr. Bennett furthermore, as Mr. Wallace subsequently pointed out,† fails to take into consideration the fact that each butterfly produces not only one, but numerous offspring, that the right variation has, by the hypothesis which he combats, a greater chance of surviving than the rest, and that at each succeeding generation, the influence of heredity becomes more and more powerful, causing the chance of the right variation to become greater and greater. He also appears to forget that this imitation in butterflies is of comparatively rare occurrence, and that the mimickers generally belong to genera which naturally show a tendency to depart from the normal coloring of their own family and to approach that of the mimicked, so that the first steps are greatly facilitated. I consider therefore that the mathematical objection utterly falls to the ground; but that there is something in the closing ideas which Mr. Bennett throws out, which may yet lead to important discoveries, I can very well conceive. Indeed it must be rash to deny some such influence as he describes when we reflect upon the extraordinary power which the mind of the mother exerts, during pregnancy, on her offspring; and when we further consider that Mr. Wallace himself admits that man's present mental and physical condition could not have been brought about by natural selection alone. It must be obvious to every one, however, that such an admission is no argument against the theory of Natural Selection. All other modifying influences though they may lessen her potency simply assist her in her grand work.

The next objector we find in Mr. Saml. H. Scudder of Boston, Mass.,‡ who, while admitting that there can be no possible doubt of the fact of mimicry, questions its advantage among butterflies, since the greatest destruction occurs in their preparatory states. But as he refers especially to the two butterflies we have been treating of and as from the context it appears that he is also aware of the existence of some of the parasites which I have described, I will quote the greater portion of his letter which was written from Cairo, Egypt, under date of November 9th, 1870; and, will afterwards reply to his objections:

"But of how much actual benefit to the mimetic species is this so-called "protective" resemblance? It seems to occur where it can be of the least possible advantage to the species. The great sources of destruction here, as in all groups of animals, are in early life. How large a proportion of the eggs that are laid by butterflies ever finally produce imagines? Let those answer who have attempted to follow their history in their native haunts. My experience leads me to believe that at the very least, nine-tenths—perhaps ninety-nine hundredths—never reach maturity. Hymenop-

*A most remarkable case came under my notice the past summer. From a single batch of flattened and ribbed eggs, overlapping each other under a piece of Hickory bark, I succeeded in raising eighteen imagines of *Catocala phalanga*, Guen. The upper wings vary greatly in the individuals, and in one specimen the ground-color and markings are so very aberrant, that there is more difference between it and some of the others belonging to the same batch, than there is between the latter and a dozen distinct species.

†*Nature,* III, p. 49.

‡*Ibid,* Vol. III, p. 147.

terous and Dipterous parasites beset them at every step. The eggs, although so small and often so heavily ridged, cannot escape the ovipositors of the tiny Pteromali, while in attempting to breed caterpillars taken in the field, the chance is so greatly against the evolution of a butterfly, that Hymenopterists actually choose this method of supplying their cabinets. 'Of two hundred larvæ of *Pieris brassicæ*,' Mr. Drewsen, of Denmark, writes to me, 'I obtained only twenty pupæ, all the rest were attacked by *Microgaster glomeratus*, and my own attempts with the larvæ of *Pyrameis Atalanta*, both in America and Europe, have been even more unavailing. These caterpillars seem to be peripatetic banqueting halls of Microgasters and Tachinæ.

"Now it is a curious fact that while the globular egg of *Limenitis Misippus*,* with its deeply-pitted shell, defended by long filamentous spines, is constantly attacked by parasites; and the grotesque hump-backed, strangely-colored caterpillar of the same species is likewise infested to an extraordinary degree, I have been unable to discover by very careful search any evidence that the egg or larva of *Danais Archippus* is ever pierced by a parasite; yet the egg is not small and only lightly ribbed, and the caterpillar large, fleshy, smooth-skinned, and gaily banded, living on the widely-separated leaves of Asclepias, with no attempt at concealment. The abundance of the imago of the Danais is then due quite as much to the immunity of the egg and larva from the attacks of parasites, as to any freedom it may itself enjoy from pursuit by insectivorous birds. [1.]

"Although I have hunted butterflies for fifteen years, I confess I have never seen one in a bird's bill, and my faith in that method of lessening their numbers is very slight. Birds, too, must be their greater foes in earlier life; and the chances of living, which are certainly against them before they take wing, seem afterwards rather in their favour, at least, until they have accomplished their mission. [2.]

"If, then, such an extraordinary element as Mimicry is to be summoned to the aid of Natural Selection, and can perform its task in such a masterly manner, why has it been made to waste its energies upon unimportant material? If the object of the resemblance be protection, why does not the unfortunate caterpillar of the Limenitis mimic the more favoured larva of the Danais? [3.]

"I cannot now consult the writings of Messrs. Wallace and Bates, nor do I remember their statements respecting the abundance of the mimetic species compared to that of its normal congeners. In my own country *Limenitis Misippus* is, as a general rule, more common than *L. Ursula*, but the difference in their numbers is not very marked. It is by no means as great as one would expect had Mimicry in the imago state so strong a protective power as has been assumed. [4.] Two closely allied species occupying the same geographical area, do not often occur in the same abundance, whatever be the cause, and the disparity in numbers in these two species of Limenitis is no greate than occurs in many instances where mimicry plays no part. [5.]"

[1.] No one will deny the facts, after what I have already set forth.

[2.] Such an experience from a butterfly hunter surprises me Individually I have on several occasions seen butterflies captured by birds, and have seen Dragon-flies dart after them. Any amount of evidence might be collected on this head, and Mr. Scudder has already been answered by Mr. Arthur G. Butler† of the British Museum, who mentions often having seen birds catch and devour the unprotected species upon the wing, while he has received abundant evidence respecting the immunity of the *Danais* group. "T. G. B." of St Johns College, Cambridge, has also often seen the common English sparrow capture *Vanessa urticæ* and *Pieris rapæ*‡; while Mr. Wallace has shown that great numbers of butterflies are destroyed on the wing by insectivorous birds such as jacamars, trogons and puff-birds, and gives conclusive evidence that while our Disippus congeners, the *Nymphalidæ*, suffer such persecution, the Archippus congeners do not.§ Thus, though there

*The reader must bear in mind that *Misippus* is but a synonym for *Disippus*.

† *Nature* III, p. 165.

‡ *Ibid*, p. 166.

§ Contributions, etc., p. 79.

seems to be no record of any person having actually seen a bird or other animal attack the species of *Limenitis* in this country, there is every reason to believe that they will do so. This fact once being admitted, it must also be admitted that the resemblance of *Disippus* to *Archippus* serves the former as a protection. I freely grant, however, that the species of *Limenitis* are kept under by enemies far more in the preparatory states than in the perfect state; but this fact only adds importance to the mimicry of *Disippus* as throwing light upon its greater numbers. The larvæ and pupæ of *Ursula* and *Disippus* so closely resemble each other that it is not likely their enemies would make any discrimination between them; and if in a given district where *Archippus* is abundant, the two former species, by the undue multiplication of their enemies in some particular year, should be so thinned out while in the immature states, that only a dozen imagines of each were perfected in an area of say 100 square miles; it becomes obvious that by deceiving the birds, or by associating with *Archippus*, the twelve specimens of *Disippus* would stand a much better chance of escape than those of *Ursula*, and that consequently more would succeed in perpetuating the species.

[3.] Natural Selection *does not*, therefore, waste its energies upon unimportant material, in giving protection to the perfect insect; and any one, with a little reflection, will perceive that there are the best of reasons why the unfortunate caterpillar of *Limenitis* cannot mimic the more favored larva of *Danais*. *They never come in contact!* The perfect insects are enabled by flight to associate together; but their larvæ—the one being confined to plants of the Willow and Poplar families, the other strictly to those of the Milkweed family—can never so associate. That there is, however, an effort at protection in the preparatory stages of *Limenitis*, no entomologist who has studied them in the field will deny. The egg, as Mr. Scudder has admitted, is in a measure protected by the long filamentous spines, which may protect it from the attacks of some of the very numerous parasites that might otherwise aid in exterminating it. The larva is very variable, and wears a remarkable protective resemblance to its surroundings. I have often noticed that in the mature specimens found on the dark Scrub willow the dark colors predominate; that those found on Golden willow are much brighter and greener, and the palest specimen I ever saw was found upon Silver poplar. Only those who have diligently searched for these larva can fully appreciate the protection which their appearance affords. In one instance I chanced to espy a large full grown specimen of *Disippus* on a Golden willow not more than seven feet high. The specimen on account of its brightness and greenness struck me as remarkable, and I searched for others. In taking a casual glance I could detect none, but after a diligent search I succeeded in finding seven specimens, and then left, fully convinced that I had espied every one upon the tree. The next day, however, my confidence in the sharpness of my eyes was considerably shaken, for upon returning to the same small tree I succeeded in finding three more, all of them more than half grown.

As to the chrysalis, it bears a very strong resemblance to a bit of bird dung, and for the first few hours of its being, while the parts are yet soft and elongated this resemblance is truly striking.

[4.] I have shown that the disparity in numbers between *Disippus* and *Ursula* is very marked in the Mississippi Valley, and there is every reason to believe that the former is most abundant wherever its protector, the Archippus butterfly, abounds. I have Mr. Scudder's own authority for the statement that the latter is comparatively rare in the northeastern States, and my own experience would indicate such to be the case. Now it is extremely probable that where *Archippus* abounds, birds and other natural enemies are continually reminded of its nauseous qualities both by smell and taste.*

It would very naturally follow therefore, that where *Archippus* is rare, birds would not be so continually warned of its evil properties, and the deceptive resemblance in Disippus would lose much of its protective power in such a case. This explanation of the fact that *Ursula* is in some districts more common than *Disippus* will acquire greater force, if we find that such a state of things occurs only where *Archippus* is rare, and the facts as they at present stand indicate such to be the case.

Mr. Wallace† is inclined to account for the fact that *Ursula* is in some districts as numerous, or more so than *Disippus*, on the supposition that *Ursula* is also a mimicker, resembling the Philenor swallowtail (*Papilio philenor*, Drury‡) especially on the underside, which is exposed when the insects are at rest. We must, however, be very cautious in accepting such resemblances as cases of mimicry, without first ascertaining whether there can be any real cause for mimicry or whether the two butterflies ever associate together. Under the circumstances I incline to believe that the markings on the underside of *Ursula* are of a generic character since they obtain in other N. A., species of *Liminitis*; and that the resemblance to *P. philenor* is merely casual and bears no more relation to mimicry than does the close resemblance of certain plants belonging to different continents. *P. philenor* is itself a rare insect where *Ursula* is common, and must always be so on account of the scarcity of its food-plant; and, if anything, *Ursula* bears a greater general resemblance to *P. troilus*, Linn, and *P. asterias*, Drury, which are both more common species. It also bears a greater resemblance upon the upper surface to the female of *Argynnis Diana*, Cramer.

*A singular fact bearing on this point has been communicated to me by Mr. Otto Lugger of Chicago, a gentleman who takes much interest in entomology and is a good collector. While employed on the U. S. Lake Survey he once saw a bird dart after an Archippus butterfly, seize it and immediately drop it without devouring the body. The butterfly dropped close by his side and he picked it up and examined it, and had no means at the time of accounting for the singular action of the bird.

† *Nature* III, p. 166.

‡ See my 2nd Rep. Fig. 86.

[5] This in no wise alters the fact, however, of the existence of mimicry in *Disippus*, which Mr. Scudder fully admits. It is, therefore no argument against Natural Selection having produced such mimicry. Because we are able to explain the principle power working to produce the relative abundance of one species, compared with another that is closely allied, it does not follow that we must also give the varied influences which cause the relative abundance or rarity of other species in other groups!

The third objector is Mr. A. Murray, who undertakes to show that these mimetic resemblances have nothing to do with Nnaural Selection.* He takes it upon himself to assert that every inch of ground which Mr. Bates has gone over is "mined and unsound"—that the "bad smell has not been observed in North America where similar mimicry occurs"; and that "birds and insects of prey hunt by sight and not by smell." Any one who will take the trouble to carefully read the paper in which these assertions occur, will, I have little doubt come to the conclusion that it is the author's ground which is "mined and unsound." The second assertion, as I have already shown, is false; and even if the third is admitted, it does not in the least affect the argument in favor of Natural Selection, because the fact nevertheless remains that some groups do enjoy immunity from the attacks of birds while others do not. The manner in which Mr. Murray would account for this mimicry is by hybridization, and he endeavors to draw a parallel between the phenomenon and hybridization in plants. He carries little weight in his arguments, which were in a measure anticipated by Mr. Bates himself, and have since been refuted by Mr. Butler and Mr. Wallace.† He forgets that hybridization cannot play any part in the mimicry of insects to the vegetable kingdom, or to backgrounds generally. It has never been known to occur between insects of different Orders, families, or even genera, and produce fertile offspring,‡ while mimicry does occur even between insects of distinct Orders; and though he of course supposes the hybridization to have taken place at a very remote date, when the structural characters of the mimickers and mimicked were less specialized, yet had such been the case, these structural characters would not now remain so distinct between them, because it is quite fair to suppose that the hybrids would partake of the characters of each parent. Indeed the assumption of the theory is unsupported by facts. He ignores in a measure the great difference in the affinities of species belonging to the natural Orders of plants, and those belonging to the Orders of insects, and depreciates the importance of the latter by comparing the Orders

Nature III, pp. 154-6.

† *Ibid.*, III, p. 165.

‡Cases of hybridization even between species of the same genus are very rare, and it is doubtful if the hybrids would ever be fertile; and as to hybrids between genera I do not think a case has ever been recorded. In 1865 I succeeded in obtaining thorough coitus between a ♂ *Attacus cynthia*, Hubn., and ♀ *Attacus cecropia*, Linn., but for some reason the eggs resulting from this intercourse did not hatch. Last year I succeeded in producing an equally thorough coitus between a ♂ *Attacus cecropia*, Linn., and a ♀ *Attacus polyphemus*, Linn., but the eggs subsequently deposited by the latter were likewise infertile.

simply to families in other animals—thus showing that he has not a due appreciation of the true affinities of insects.

It must not be forgotten that Natural Selection is not the only power at work producing this mimicry. This we do not claim. There is an inherent tendency in all things to vary—a fact universally admitted. We may not be able to fully comprehend the causes producing this first variation, for they are complicated, and depend on numerous external conditions, and physical and mental influences. But our ignorance in this respect does not affect the theory, because "spontaneous" change is the material out of which Natural Selection has fixed and perfected the mimicry and adaptation; and it is not necessary to know how the "spontaneous" change is produced to learn the origin of the mimicry. Whatever be the causes of variation, and whether or not they continue to act after the first change takes place, Natural Selection is still potent, for the change would be perfectly inoperative in producing specific character without it.

There may be a hundred different influences that have led *Disippus* to mimic *Archippus*. The resemblance being purely colorational, there may have been a tendency from the first in the color of the former to approach that of the latter, and this is rendered very probable from the fact that the red-brown color occurs more or less in all the N. A. species of the genus.*

The very smell which protects *Archippus* may have had, and may still have, attractions for its mimicker, for Mr. Henry Edwards found that a Californian species of the same genus (*Limenitis Bredowii*) was greatly attracted by any offensive odor.† Again, when we reflect that we owe so many of our flowers and fruits to what are called "sports," which are simply instances of great and sudden variation; it is not difficult to imagine that the mimicry of *Disippus* may be due in a measure to some such sudden original variation—an idea that is greatly strengthened by the fact that instances of such great variation are common with butterflies and moths, and that one is known to occur in the very genus *Limenitis*.‡

We may give due weight to the somewhat Lamarckian theory advanced by Mr. Bennett; we may attach the greatest importance to the influence of physical conditions—and we know that similar habitat sometimes produces modification of allied forms in a similar direc-

* In the seven described N. A. species of *Limenitis*, namely, *L. disippus*, Godt., *Ursula*, Fabr., *Proserpina*, Edw., *Weidemeyerii*, Edw., *Arthemis*, Drury, *Lorquini*, Boisd. and *Bredowii*, Hubn. the red color obtains more or less in all of them, especially on the under side, and this is more particularly the case in the last two. I also possess specimens of *Ursula* in which a very distinct shade of red blends with the blue-black and spreads over the upper surface of the primaries, and is in two individuals quite marked towards the apices. That the blue and black is closely connected with, and shows a tendency to affiliate with the brick-red and black, or *vice versa*, we may also reasonably infer from the wonderful contrast existing between the ♂ and ♀ *Argynnis Diana*, Cram., the former colors obtaining in the ♀ and the latter in the ♂.

† *Butterflies of North America*, by Wm. H. Edwards. It is impossible to make any explicit reference to this beautiful work as it is not paged: this, to my mind, is a deplorable oversight.

‡ *Limenitis Sibylla* figured in "Newman's English Butterflies," and referred to by S. N. Carvalho, Jr., in *Nature*, Vol. III, p. 66.

tion—but all these agencies will not produce specific imitation of one species by another, for they only prepare the way for it. It is therefore quite evident that such imitation can only be brought about to use Mr. Bennett's own words, "by the continuous preservation, through countless generations of those individuals which spontaneously approach most nearly to the ultimate forms;" and Natural Selection is the Preserver.

I have thus endeavored to frankly consider the objections raised against the theory of Natural Selection, as it applies to the mimicry of our two N. A. butterflies. It would be out of place here, and might justly be considered a work of supererogation on my part to undertake to defend it on more general grounds. It has been so well developed by Darwin, Wallace, Bates, and many other writers, both English, French and German, that it only asks a hearing to be understood and appreciated. The rapid increase of organisms is demonstrable, and the consequent struggle for existence, since, all organisms considered, there are as many deaths as births, is manifest. The result of this struggle is the survival of the fittest, by which organic forms are constantly changing to keep in harmony with the changed conditions which it is demonstrable have taken place, and are still taking place, in the inorganic world. And, to use Wallace's language, "as the changes of conditions are permanent changes in the sense of not reverting back to identical previous conditions, the changes of organic forms must be in the same sense permanent, and thus originate species."

That its influence and importance has been overrated by some writers is not at all unlikely, for Mr. Darwin himself now believes that he at first attributed too much to its action; and certain it is that it could have had no influence in producing many purely ornamental features of certain animals, that are of no use to the species thus ornamented. No theory was ever yet propounded, however, which has so well stood the test of scientific investigation in all departments of research, or that has such a power of absorbing new facts; and no theory has in such a short time been so very generally accepted by the leading scientific minds.

A two-fold reason has led me to give it prominence in this Report. First, I believe that when well understood it must prove of the utmost importance to the husbandman, by giving him an intelligent conception of the growth and development of animal and plant life about him, and by adding zest and interest to his efforts to produce superior varieties and breeds. Secondly, my studies of insect life led me several years ago to appreciate the hypothesis, and the more I become acquainted with these tiny beings in the field, the more I become convinced of its truth and importance. It is not to be wondered at that the entomologist who treats the different varieties in any group as independent species, should have implicit faith in the absolute distinctness and immutability of species; but whenever he pays more attention to the biological part of his science, and studies insects more in the field, his views must necessarily change. Indeed, next to plants, insects offer, perhaps, the best material for the inquiring mind to work upon. Their rapid multiplication, the rapid manner in which one generation is often followed by another, the wonderful manner in which they are often affected by climate and food, especially during the preparatory or adolescent stages—all tend to furnish variation for Natural Selection to work upon, in a profusion unknown in the higher animals. Though the formation of a species in the other Classes of animals may never be in man's power to trace, on account of the great lapse of time required; it seems highly probable that the process may some day be traced in insects, and Mr. Bates gives strong proof of the derivation of one butterfly (*Heliconius thelxiope*) from another (*Heliconius melpomene*) and a clear insight into the manner in which the gradual modifications take place, till at last the two forms cease to interbreed, and are in every sense of the word true species.*

After all, the great objection to the theory of Natural Selection, in the minds of many, is, that it involves belief in the broader doctrine of Development—of Evolution. Very true! But, no matter how much importance be attached to Natural Selection, the fundamental truth of the development of species is now almost universally accepted by scientific men best able to judge of its merits; and those who have not considered the subject may be excused from judging of it. Indeed it can hardly any longer be considered a hypothesis: it is in reality established as a law, and as eminent a naturalist as Carl Vogt has even ventured the assertion that "no one in Europe dares any longer sustain the independent and direct creation of species." Development is a fact in nature, and the revelations of science strengthen faith in the universality of her laws and principles. No one can study well the facts in natural science, or the truths of philology, which point to corresponding results, without feeling more strongly than ever words can express, the general truth of the doctrine. Our own Agassiz is about the only great naturalist who opposes it, though it is rather significant that many of his leading pupils have, within the last few years, boldly proclaimed their faith in Darwinism. If there is one error in Agassiz' life, I take it to be the authority which he has lent to that popular prejudice which has always opposed inquiry into the order of nature, and which has ignorantly accused Darwin of atheism.

A theory which is so opposed to deep-set tradition and to present theological interpretations, must necessarily at first meet with very great objection. Such has been the history of all great scientific truths, for we have Agassiz' own words that "the history of the sciences is present to tell us that there are few of the great truths now recognized which have not been treated

*Naturalist on the River Amazons, Vol. 1, pp. 255–265.

as chimerical and blasphemous before they were demonstrated.' Truth must, however, in the end prevail!

Science and theology have little in common, and will, perhaps, always be at variance, but science and true religion are twin-sisters, and will ever go hand in hand. In the present question, theology affirms supernatural causes beyond man's investigation, and consequently sets an embargo on inquiry; while science affirms natural causes within the limits of investigation: the one appeals to man's senses, the other appeals to man's reason, whose throne should never be abdicated, and whose power to trace effects to antecedent causes is unlimited.

The belief that Darwinism is irreligious and atheistic, is widespread; but this belief is the direct result of prejudging and unfounded prejudice. For no one who understands the theory can entertain such an idea for a moment. The individual is not created by a special miracle, but develops by natural means. Yet no one would claim that the individual was any the less a creation. And so when it is argued that species also develop by natural means—according to natural law; they are none the less therefore creations! It is only a question as to the method which the Almighty employs; for not only does the development hypothesis imply an Infinite cause, but to use Prof. E. L. Youman's language "its conception is as much grander than the common theological idea, as the conception of the Cosmos which science has revealed, transcends the petty ideas of the world which were entertained in the grovelling infancy of the race!" Creation by a process of development is tangible and conceivable, whereas we can have no knowledge and no conception of creation without any process.

Haeckel, one of Darwin's strongest supporters, says: "In recognizing the unity of nature and the efficacy of the Divine Spirit in everything, we may perhaps lose the hypothesis of a personal Creator, but we evidently gain the idea of a Divine Spirit, which pervades the whole universe. God is the highest, the most living, the most active unit through all things which only appear as sensuous representatives for sensuous creatures." Can such men be called atheists or materialists?

The supposition that the creative mind produced all things as we now find them, by a single act of unstinted power, requiring only such time as can be reckoned by ourselves, is the direct outgrowth of our own comparatively feeble minds—is to gauge the power of the Almighty by our own. The supposition that he works through natural law, originally ordained, and by a constant exercise of his prerogative, is a far higher and more comprehensive conception; for it helps to broaden our views and enables us to grasp something more than we have hitherto done. It carries us back æons in the past, and shows us that creation has not only been continuous but still endures, and it helps us to rise to sublimest contemplation of that unknown Infinity which pervades all.

Von Baer has truly remarked that "the scientific investigation of Nature strives to learn everything in detail, in order to get nearer to the cause of everything," and though we may not always reach the goal we aim at, we should not therefore cease to try. The law of the age is progress, and the point we reach to-day will form our starting point to-morrow. Every step which enables us to more truly interpret the workings of the Divine Mind in nature, necessarily brings us nearer to, and gives us a more intelligent idea, of a Creator. Each new insight into the significances and harmonies around us, helps us to lift the mystic veil and behold with awe and wonder the might and majesty of God—to converse with him as flesh with unknown Infinity: and I look forward to the day when the development of species will not only be universally recognized as a law, among naturalists; but when the liberal-minded theologian will revere the names of men like Darwin, who help to a higher conception of creation—instead of anathematizing them and ignorantly charging to their doctrines those atheistic tendencies which in times past have been vainly thrown up to those of so many other great, clear-thinking, discovering minds!

ERRATA.

Page 7, line 18 from bottom, for "*Hylcœctus,*" read "*Hylecœtus.*"
Page 57, line 18, add "*c*" before the first "*h.*"
Page 58, line 2 from bottom, for "*fornudolosus*" read "*formidolosus.*"

ERRATA OMITTED IN THE FIRST REPORT.

Page 14, line 16 from bottom, for "females" read "males." Page 30, note, for "F" read "T." Page 32, line 14 from bottom, for "III" read "V;" same page, line 7 from bottom, for "XIII" read "VIII." Page 38, line 5, for "*Tredeim*" read "*Tredecim.*" Page 53, line 19 from bottom, for "laid" read "lain." Page 54, line 4 from bottom, for "hatch" read "are deposited." Page 87, line 11 from bottom, for "F" read "T." Page 132, line 16, for "*ampelopsis*" read "*ampelopsidos.*" Page 150, line 6, for "ruddy" read "vigorous;" same page, line 26, for "*thyridopteryx*" read "*thyridopterygis.*" Page 154, in the heading, for "*zeas*" read "*zeæ.*" Page 155, line 13 from bottom, for "zeas" read "zeæ." Page 173, line 3 from bottom, for "it" read "the more liquid parts;" same page, under the heading, read ("Lepidoptera, Tineidæ.") Page 174, line 3 from bottom, for "*Solidaga*" read "*Solidago.*" Page 175, line 32, add "front" before "wing." Page 178, lines 2 and 3, for "*gelechia*" read "*gelechiæ.*"

INDEX.

A

B

C

D

E

F

G

H

I

L

M

N

O

P

Q

S

T

V

W

X

SEVENTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL,

AND OTHER

INSECTS

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
State Entomologist.

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PREFACE.

To the President and Members of the Missouri State Board of Agriculture:

GENTLEMEN: The following pages constitute my Seventh Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

As its contents show, the year 1874 has been remarkable for the wide-spread suffering that insects injurious to Agriculture have entailed, especially in the Mississippi Valley and the country to the West. Our own State, though not suffering so much as some of her sister States, did not escape immense injury. Added to a severe drouth, which shortened most crops, our farmers suffered much more than usual from the ravages of the Chinch Bug; while in the western counties they also suffered from the visitations of the Rocky Mountain Locust, or so-called "Grasshopper," which spread such desolation over so large a portion of the fair West. Both these insects receive that large share of attention in the present Report which their importance and the interest just now attaching to them demand. Still a third insect, namely, the Flat-headed Apple-tree Borer, has been unprecedentedly abundant and injurious to our fruit and shade trees, and it gives me pleasure to lay before the people some new facts which will help to a better mastery of it.

A law passed by the last Legislature not only changes somewhat the mode of binding and distributing the Agricultural Report, of which this forms a part, but increases the edition from six to twelve thousand, and limits the number of pages it shall contain to 500. Finding that the articles on the noxious insects, of which this Report treats, occupy more than the ordinary number of pages allotted to me, I have deviated somewhat from previous custom, and omitted the chapters on Beneficial and Innoxious Insects, with which its predecessors have ended. In the article on the Rocky Mountain Locust, the reasons are given at length why I believe that this plague will never do serious harm beyond a certain line there indicated. It gave me no small satisfaction to be able to allay last Fall the fears our farmers east of that line entertained of being overrun by the pests. For some years past, Kansas, by one means and another, and especially by a liberal policy on the part of her Legislature toward her State Horticultural Society, has done all in her power to attract immigration. Our own State government has repeatedly refused the appeal of our State Horticultural Society for small appropriations to enable it to exhibit the fruits and advertise the resources and capabilities of the State; and other measures intended to encourage immigration have been left without support. The consequence of such legislative neglect, and of other less avoidable occurrences, was seen in the trains of emigrant wagons that during the last two or three years have been passing through our State, bound for Kansas or some more western point. The locust invasion of 1874 checked the tide of emigration to Kansas and the further West, and even turned it back again; and I have every reason to believe that the assurance that Missouri is essentially safe from the devastations of these locusts will have no inconsiderable influence in staying that immigration within our borders in the future.

There yet are, and doubtless ever will be, those who—dwelling in cities, and familiar only with such lectularious insects as cause them bodily inconvenience—have little appreciation of Agriculture or of Entomology in its connection with it; and consider the study of " bugs," as they contemptibly call everything that creeps, a fit subject for ridicule. When, however, a single insect, like the Chinch Bug, filches nineteen million dollars, in a single year, from the pockets of the farmers, and reduces in so much the wealth of the State ; even such persons may be brought to admit that any study having for object the reduction of this immense loss, is not necessarily contemptible, small as the objects may be with which it deals. Fortunately, such persons are becoming fewer and fewer, and the following pages bear witness to the fact that not only in several States in our Union, but in several countries of the " Old World "—in monarchies, empires and republics alike—the authorities have manifested a remarkable appreciation of economic Entomology. We have, during the year, witnessed Australia and New Zealand discussing and attempting the introduction from Europe of Aphis parasites to check the alarming increase of those plant pests; and of bumble bees to enable the farmers to grow their own clover seed. We have seen France increasing her premium for a Phylloxera remedy to three hundred thousand francs, and considering plans, for the destruction of the pest, of constructing an irrigation canal to supply 60,000 acres. We have seen Massachusetts memoralizing her Legislature to pass " An act for the destruction of Insects Injurious to Vegetation;" while some of our own State Legislatures have been convened in special session to consider means of relieving the sufferers from insect ravages, and several European governments have, with forethought and wisdom, taken such measures as seemed best to prevent future injury from still other insect pests.

The fact that the Agriculture of the United States is of equal material importance with all the other interests of the country combined is so often asserted and admitted that it needs no enforcing. This industry not only feeds our own forty million mouths, but supplies the staff of life to millions in foreign lands. Surely, then, it is most important to study and investigate those causes which affect it injuriously and arrest its development, among which injurious insects play such an active part. When, as last year, the prosperity of whole States is jeopardized, and the whole nation suffers most sensibly from these depredators, national measures should be taken to investigate the causes and endeavor to prevent the recurrence of such disasters in the future. I have already referred to the immense loss which the Chinch Bug caused us last year, my estimates being based on returns obtained from farmers from the different counties. Yet, though the sum demonstrably amounts to millions, many of our legislators and some of our journalists would laugh at me were I to ask for an appropriation of five or ten thousand dollars to be expended in experiments which might result in giving us a perfect, or at least a much better remedy for the evil than any now in our possession, and thus save the whole or the larger part of this immense annual loss. Experiments on a sufficiently thorough and extensive scale can never be undertaken by the few State entomologists now employed, with salaries of two or three thousand dollars, from which they pay their expenses. The means will not justify them and the time of such officers is occupied with the study of not one or two, but of hundreds of species, many of them local in character. In cases, as with the Locust, the Chinch Bug, the Cotton Worm, etc., where the evils are of a national character, a national Commission, appointed for the express purpose of their investigation, and consisting of competent entomologists, botanists and chemists, is necessary, and should be demanded; and I am glad that preliminary steps have been taken by some of our leading scientific men to memoralize Congress to create such a Commission, the members to be chosen by the Council of the National Academy of Science, and approved by the Secretary of the Treasury.

We have, it is true, a Department of Agriculture which, if under intelligent and scientific control, might employ the large sums it now fritters away in the gratuitous distribution of seeds, to better advantage in organizing and sending out such a Commission; but the people have lost all hope of getting much good out of that institution as at present organized, or so long as the character of its head and management depends on political whim or fancy.

I have referred in previous years to the binding and distribution of the Entomological Report, and suggested that improvements might be made in the law. In some respects the new law, already referred to, is a great improvement on the old one, and will have a tendency to bring these reports before the farmers, in a manner in which they have not been brought before them in past years, if we may judge from the experience of the many whose letters I partly publish in the Chinch Bug Appendix. My 6th Report was published last April, and a word or two as to its distribution may not be out of place. At the approach of Summer it began to be rumored, and it finally became manifest, that your late Corresponding Secretary, Mr. J. F. Wielandy, decided not to publish a report. As mine is bound in by law with that of your secretary, and I did not wish it to lay the whole year at the bindery, I took measures to have it bound and distributed separately, and, after conferring with the Governor and Secretary of State, and the officers of the Board, and getting the sanction of my intended course from each individual member of the Board, it was so ordered bound and distributed.

At the request of a committee appointed by the Board of Curators of our State University to confer with me on the subject, I agreed a year ago to prepare a collection of insects for the use of the Agricultural Department of that Institution. During the year I have devoted what little time I could spare, and all the time of an assistant, Mr. Lugger, not absolutely needed in other directions, to the preparation of this cabinet, which I took to Columbia last December, and delivered to the College. It consists of sixty drawers, 12 by 16 inches, with a depth of 2½ inches inside, and lined with cork and ruled paper—the drawers being of pine wood with cedar fronts, and the cabinet itself being of oiled walnut. It contains types of the principal insects of the State, with figures, in many instances, of their adolescent stages. These insects are all carefully mounted and properly classified, with printed, ordinal, family, generic and specific names attached, and where the species have been treated of in my Reports, there are references made to the particular Report and the particular figure. The whole forms a type collection intended for the instruction of the students, and to illustrate my lectures before the entomological class at the University; and in each drawer there is room left for the addition of specimens that may be collected by the students.

In these busy, stirring days, there are few men who get time to read through a Report on any specialty—even among those for whom such a report is more particularly intended. In the work herewith submitted there will be found matter that will interest the scientific as well as the practical man; and, fully appreciating the truth of the aphorism, *Ars longa, vita brevis est*, I have endeavored to so arrange and sub-divide the matter that the reader may refer at once to that which more especially interests and concerns him. In a work intended for future reference as well as present use, the topics are best discussed under as many sub-heads as possible.

In this, as in the previous volumes, when the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, or in works out of print or difficult of access, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. The popular name of each insect is accompanied by the scientific name, and the latter is generally printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, are also given under each heading. The dimensions are expressed in inches and the fractional parts of an inch, and the sign ♂ wherever used, is an abbreviation for the word "male," the sign ♀ for "female," and the sign ☿ for neuter.

Many of the figures are enlarged, but the natural size of each of such is also given or indicated by a hair-line, except in the representation of enlarged stuctural details, where they are connected with the life-sized insect to which they belong.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted the following plan: When the specific name is coupled with the generic name under which it was first published, the describer's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is enclosed in parenthesis, thus—*Acrobasis nebulo* (Walsh); except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g., (*Acrobasis nebulo*, Walsh).

All the illustrations, except Fig. 30, unless otherwise stated, are drawn by myself from nature.

My office is still at Room 42, St. Louis Insurance Building, N. W. Corner of Sixth and Locust Sts., where all communications should be sent. I regret not to be able to thank the officers of our different railroad companies for courtesies extended on their different lines. The stringent regulations which the roads have adopted have prevented my obtaining the passes which in former years materially assisted in the prosecution of my work.

Respectfully submitted,

CHARLES V. RILEY,

State Entomologist.

ST. LOUIS, MO., April 1st, 1875.

TABLE OF CONTENTS.

NOXIOUS INSECTS.

THE COLORADO POTATO BEETLE—*Doryphora* 10-*lineata* Say.

(Ord. COLEOPTERA; Fam. CHRYSOMELIDÆ.)

IT REACHES THE ATLANTIC.

After narrating, in 1868,* how this insect had made its way from the Rocky Mountains, where it originally fed on the wild *Solanum rostratum* Dunal, till, in 1859, it reached a point one hundred miles west of Omaha, Neb.; how, in 1861, it invaded Iowa, in 1862, Southwest Wisconsin, and in 1864 and 1865, crossed the Mississippi to the western part of Illinois and eastern part of North Missouri; how, in 1866, it occupied most of the country west of a line drawn between Chicago and St. Louis; how, in 1867, it reached Southwest Michigan and West Indiana; and, finally, how, in 1868, it was already announced in portions of Ohio—I showed that its average annual progress eastward had been upward of seventy miles, and predicted that it would probably reach the Atlantic about A.D. 1878, or a few years earlier than Mr. Walsh had calculated some years previously, when he first traced its eastern progress and showed that it was traveling onward to the Atlantic, establishing a permanent colony wherever it went. In subsequent reports, its progress eastward was yearly recorded, and I now have to record that it reached the Atlantic at many points during the year 1874, or four years in advance of the time predicted—the increased average annual rate being due no doubt to the aid the beetles got in their onward course from ships on the lakes and from the cars on our railroads.

Early in the summer, I received undoubted evidence of its appearance on the Atlantic seabord, and it was reported during the year

*First Report, pp. 102-3.

from several parts of Connecticut, New Jersey, New York, Pennsylvania, Delaware, Maryland and Virginia.*

INJURIES DURING THE YEAR.

While the insect has been quite injurious in some of the Eastern States more recently invaded, it has attracted less attention than usual during the year in Missouri; for our farmers have come to consider it a necessary evil, and its destruction a part of potato culture. One rather curious circumstance in this connection relates to its increased injuries in its native home in the Rocky Mountains. It is a fact observed by many western travelers that the potatoes in the mountain regions of Colorado were less affected by the insect than were those of the Mississippi Valley. This was natural enough, since the wild food plants are common there, and the potato fields fewer and more scattered than further east; and, moreover, the stream which first branched off from the wild Solanum feeders, and took to feeding upon the cultivated potato and spreading eastward, doubtless took no backward course. During the past summer, however, the insect did great damage to the crops in the mountain region: yet a fact which is suggestive to the people in the Alleghanies is worthy of mention, and that is that while the injury reached three or four miles into the mountains, or to about the middle elevations (say 8,000 feet above the sea level,) the crop was entirely free from the insects above that altitude and yielded abundantly. This fact was communicated to me by several independent observers, and among others by Prof. J. H. Tice, who spent the summer at Left Hand Canon. Some observations of Mr. G. H. French, of Irvington, Ills., who also spent the summer in the mountains, to the effect that while he often found the bodies and eggs

* The following reports are the most trustworthy (the species having been identified in each instance) from among many others that might be given: The *American Farmer*, Baltimore, for July, 1874, says: "Not only in the vicinity of Baltimore, but all over the western shore of Maryland, in Delaware and in Virginia, these insects have appeared in great numbers, voraciously attacking the crops." H. P. reports it in Connecticut (*N. Y. Weekly Tribune*, July 22, 1874); E. B. M. in Cape May county, N. J., (*ibid*, August 26, 1874). In June it was at Wilmington, Del., (*Daily Commercial* of that place, June 1, 1874). E. T. reports it during the same month in Oneida county, N. Y., (*Country Gentleman*, June 25, 1874); C. F. at Olney, Md., (*ibid*, July 30, 1874). The monthly reports of the Department of Agriculture record it in Alleghany, Cattaraugus, Delaware, Erie, Madison, Tioga, Wayne and Wyoming counties, N. Y.; Burlington, Gloucester and Salem counties in N. J.; Kent county in Del.; Alleghany, Baltimore, Caroline, Cecil, Carroll, Dorchester, Frederick, Hartford, Montgomery, Prince George and Queen Anne counties, in Md.; and Culpepper, Fauquier, Greenville, Highland, Page and Prince William counties, in Va.

Finally, the following parties have reported its appearance to me by letter: Rev. John G. Morris, Baltimore, Md., from around that city; T. L. Harison, Secy. N. Y. State Agr. Soc., from around Syracuse, N. Y.; W. K. Shelmire, Toughkennamon, from Chester county, Pa.; S. Lockwood, Freehold, N. J., from that vicinity; S. S. Rathvon, Lancaster, Pa., spoke of its increase in Lancaster county; Thos. Meehan reported it swarming in June around Germantown, Pa.

above that altitude, yet the eggs, or the larvæ just hatched from them were dried up and dead, will suggest the reason, which is probably due to the very dry atmosphere in connection with the cool nights.

ALARM ABOUT IT ABROAD.

In earlier reports I have expressed the opinion that there would be real danger of the insect finding its way to Europe when once it reached the Atlantic seaboard; and now that it has done so, the authorities in several of the European countries are taking active measures to prevent such a possible calamity as the introduction of our potato beetle might prove. The potato, to some of the European peoples, is of more national importance than to us, and we cannot wonder at the alarm manifested across the water, or at the interest which the subject creates there, as evidenced in the number of pamphlets, both in French, German and English which have lately appeared on the subject in Europe, and the numerous articles written for the periodical press.

The governments of Belgium, France, Switzerland and Germany have already prohibited the importation of American potatoes, and Italy, the Netherlands and Great Britain, which have been solicited to do so, are seriously inquiring into the necessities of the case. The British Government is naturally slow to take such stringent steps, which would perhaps more deeply affect it than the other nations mentioned, since Great Britain does the larger trade in American potatoes. In reply to Mr. Herbert, M. P. for Kerry, who recently asked the Chief Secretary for Ireland whether Her Majesty's government had taken any steps to prevent the introduction of the insect, Sir M. M. Beach sought to abate fear, rather underrated the danger, and wisely concluded that any interference with the trade should first have the most careful consideration. Those who have watched the insect's gradual spread during the past seventeen or eighteen years, from its native Rocky Mountain home to the Atlantic, and have seen how the lakes, instead of hindering its march into Canada, really accelerated that march, by affording carriage on vessels, rafters and other floating objects, can have no doubt that the danger felt by our transatlantic friends is real.

Yet I must repeat the opinion expressed a year ago—and which has been very generally coincided in by all who have any familiarity with the insect's economy—that if it ever gets to Europe it will most likely be carried there in the perfect beetle state on some vessel plying between the two continents. While the beetle, especially in the non-growing season, will live for months without food, the larva would perish in a few days without fresh potato tops, and would, I believe, starve to death in the midst of a barrel of potatoes, even if it could get there without being crushed; for while it so voraciously devours the leaves it will not touch the tubers. The eggs, which are quite soft and easily crushed, could, of course, only be carried over on the haulm or on the living plant; and while there is a bare possibility of the insect's transmission in this way, there is little probability of it since the plants are not objects of commercial exchange, and the haulm, on account of its liability to rot, is not, so far as I can learn, used to any extent in packing. Besides, potatoes are mostly exported during that part of the year when there are neither eggs, larvæ nor potato vines in existence in the United States. There is only one other possible way of transmission, and that is in sufficiently large lumps of earth, either as larva, pupa or beetle. Now, if the American dealers be required to carefully avoid the use of the haulm or shaw and to ship none but clean potatoes, as free as possible from earth, the insect's transmission among the tubers will be rendered impossible; and when such precautions are so easily taken, there can be no advantage in the absolute prohibition of the traffic in American potatoes. As well prohibit traffic in a dozen other commodities, in many of which the insect is as likely to be taken over, as in potatoes, and in some of which it is even more likely to be transported. The course recently adopted by the German government in accordance with the suggestion made in my last report, is much more rational and will prove a much better safeguard: It is to furnish vessels plying between the two countries with cards giving illustrated descriptions of the insect in all stages, with the request that passengers and crew destroy any stray specimens that may be found. Let England and Ireland, together with the other European governments, co-operate with Germany in this plan, and have such a card posted in the warehouses of seaport towns, and the meeting rooms of agricultural societies; and a possible evil will be much more likely avoided. Some of the English journals are discussing the question as to whether, with the more moist and cool climate of that country, our 10-lined potato beetle would thrive there, even if imported. There cannot be much doubt that the insect will rather enjoy the more temperate clime; for while it thrives best during comparatively dry seasons, both excessive heat and drouth as well as excessive wet are prejudicial to it.

It is argued by others that on the continent of Europe our Doryphora would not thrive if introduced, and in a recent letter received from M. Oswald de Kerchove, of Gand, Belgium, author of an interesting pamphlet on the insect,* that gentleman says: "I do not think

* *L'Ennemi de la Pomme de Terre*, etc., Bruxelles, 1875.

that the Doryphora, awakened by our early warm weather, could resist the effects of the late cold which we are apt to have in these European countries." The idea that the climate of North America is less extreme than that of Europe is rather novel to us of the cisatlantic; and from a sufficiently long residence in England, France and Germany, I am decidedly of the opinion that they delude themselves who suppose that Doryphora could not thrive in the greater part of Europe; and that to abandon all precautionary measures against its introduction on such grounds would be the height of folly. An insect which has spread from the high table lands of the Rocky Mountains across the Mississippi Valley to the Atlantic, and that flourishes alike in the States of Minnesota, Wisconsin and Connecticut, and in Maryland, Virginia and Texas—in fact, wherever the potato succeeds—will not likely be discomfited in the potato-growing districts of Europe. Some few, again, have ridiculed the very idea of the insect's passage to Europe in any State, arguing that it is an impossibility for any coleopterous insect to be thus transferred from one country to another. Considering that half the weeds of American agriculture, and a large proportion of her worst insect pests, including two beetles—viz: the Asparagus Beetle (*Crioceris asparagi*,) and the Elm Leaf-beetle (*Galeruca calmariensis*)—in the very same family as our Doryphora, have been imported among us from Europe, there would seem poor foundation for such argument. Moreover, a number of other insects—among them some beetles—of less importance, may be included in the number of importations; and the Rape Butterfly (*Pieris rapæ*,) whose progress westward has been simultaneous with the Doryphora's eastward, and whose importation dates back but a few years, bears witness to the fact that insects more delicate and with fewer chances of safe transport than Doryphora, may succeed in getting alive from one country to the other, and in gaining a foothold in the new home.

The ravages of the insect, bad as they are, very naturally get exaggerated at such a distance from its native home, and the following from the London *Gardener's Chronicle*, gives altogether a too gloomy picture: "When once a field of potatoes has been attacked, all hope of a harvest must be given up; in a few days it is changed into an arid waste—a mere mass of dried stalks." It should not be forgotten that the American farmer by means of intelligence and a little Paris Green is pretty much master of the Doryphora.

One of the most amusing things growing out of the European agitation about this insect that has come to my notice, occurred in our own city of St. Louis. Our worthy Mayor Brown was importuned by a Belgian official for information about the insect, when, instead of ascertaining the facts, which he might easily have done, either from myself or from any of his bucolic friends, he chose to display his agrestic proficiency by publishing a reply in the daily papers. The following extract from the reply will show that a man may be a good mayor and yet cut a sorry figure as agriculturist or entomologist; for every reader of these reports will notice that there is scarcely a statement that is not opposed to the facts:

> Treating your letter, therefore, seriously, I have to state that there never has been a potato bug seen flying about St. Louis or any other city in the United States or territories; that the potato bug never has caused any alarm in any city nor in the country—only in certain seasons that seemed to be favorable to the production of them. I am not aware of the potato bug attacking any other vegetable. I consider the fears of the people of Belgium entirely groundless, even if the ravages of the potato bug had been great in any locality the past season (which it has not,) and is a matter of no apprehension or comment at the present time in this country.

Mayor Brown, though he has the reputation of being extremely versatile, has evidently not worked in a potato patch of late years! Nor did his letter seem to inspire much confidence among the Belgians, who, soon after its publication, passed an act prohibiting the importation of American potatoes.

IS IT POISONOUS?

This question, which was very fully discussed, pro and con, between the years 1866 and 1870, and settled in the affirmative, has been revived again by Prof. T. J. Burrill, of the Illinois Industrial University, who published an item, which went the rounds of the agricultural press, to the effect that the insect is not poisonous; a statement he supported by the facts that he had rubbed the juice from the mashed insect into a flesh cut, and had had some accidentally squirted into his eye, without any injurious effects resulting. Now I would not go to the extent of a certain sarcastic Chicago professor who affirms that he could fix up a decoction from the dead beetles that would cause a vacancy in the chair of Vegetable Physiology and Horticulture in the Illinois Industrial University, if Prof. Burrill inhaled it, and suggests that there are certain animals that poison will not affect, and that Prof. B. may be one of them; nor to the extreme of a Philadelphia physician who asserts that the tincture from this beetle is the most virulent of insect poisons, and that nothing can be compared with it except the Argas of Miana, in Persia, and the Coya in the valley Neyba, in Popayan, South America, according to Ulloa's Travels, Vol. I, p. 343.* Yet there are so many authenticated cases of poisoning

* See an article in the Transactions of the Homœpathic Medical Society of the State of New York, Vol. VIII, pp. 142-169, 1869, by E. M. Hale, M. D., of Chicago. In this article, which is mostly a quotation from the *American Entomologist*, with four poorly-colored lithographic plates made mostly from my wood-cuts, without credit, Dr. Hale brings together several well authenticated cases of poisoning.

by the fumes from the scalded insects, that it is surprising that Prof. Burrill should have so stoutly assumed the negative of the question without further research and experiment. It is as if I, who am not affected by poison ivy or bee sting, should insist on the harmlessness of either, in the face of their well known poisonous qualities, and their danger to many persons. I know of physicians who persist in disbelieving that death was ever caused by calubrine poison because they have never known a fatal case of snake-bite in their own experience; but skepticism of that which is outside one's own experience usually dwells most where that experience is limited. Since my acquaintance with the Colorado Potato-beetle, three cases of its poisonous influence have been reported to me by persons in whose judgment and veracity I have the utmost confidence,* and without for a moment doubting the facts Prof. Burrill has recorded, which are valuable as far as they go, I would simply say that they do not go far enough, and he has not solved the whole truth of the matter. That the juices of the mashed insects on the human skin are, as a rule, harmless, is proven by the hosts of farmers who have crushed them by hand, and I can testify to the fact from my own experience; indeed, scarcely any one who has had experience believes the wild stories of the poisonous nature of these juices. Yet the rule is not without exceptions, and I do not doubt that, with blood in certain bad conditions, persons have been poisoned by getting said juices into wounds or cuts. But the cases of undoubted poisoning from this insect—cases that have in some instances been serious and even proved fatal—are not from the juices of the body, but from the *bruising* or crushing of large masses, especially by burning or scalding large quantities at a time. The poison seems to be of a very volatile nature, and to produce swelling,

* Even since this was written, and just as this Report is going to press, the following letter, under date of March 15, 1875, came to hand: "On June 1st, 1874, I was called to see a little boy, son of Mr. E. H. Torgis, residing in a little village about two miles from this city. I found the child unwilling to speak, with jactitation, quick breathing, florid condition of the skin, spitting viscid, frothy phlegm; at times a quick, rather rapid pulse, and shortly after my arrival a peculiar spasm. The case was puzzling to me, but that it was a case of poisoning from some source suggested itself at once. I made diligent inquiry into the case, and eventually the father described to me the manner in which the boy would gather his apron full of potato bugs and sit down by a flat stone and by the means of another stone would mash them one at a time. Of course, in so doing he inhaled the volatile properties of the insects' juices. The case was antidoted by the proper antidotes for such a case with marked results. On my second visit made in the evening, I found the face the same in appearance, but the temperature of the skin markedly different; the jaws were slightly relaxed and there was high fever. I then paid some attention to these symptoms, and after making three more visits discharged the case. Another case came to my notice. It was that of a farmer's wife who was in the habit of daily gathering the bugs and scalding or burning them. She was seized with swelling in the hands, burning in the stomach and distension of the abdomen. I attributed it to the same cause, and relieved it accordingly. I also saw two other cases somewhat similar, and from these observations am most thoroughly convinced that the insect is poisonous. J. H. FISHBURNE, M. D.

LOCK HAVEN, PA.

pain and nausea very much as other animal poisons do, and Dr. C. Ruden, of Joliet, Ill., who, as quoted by Dr. Hale (*loc. cit.*, p. 103), experimented on himself by taking the saturated tincture internally —increasing the dose daily from two to twenty drops—experienced great disturbance of the bowels, swelling of the extremities, bloated face, protruding eyes, fever, great thirst and desire for something acid.

From the present state of the case, therefore, while there can be little danger in the cautious killing of the insect in the field, I would not advise recklessness in handling it in large quantities; and we should especially guard against collecting and destroying it by scalding or burning in such quantities. There is no longer any occasion for thus collecting and destroying the insects; and since the custom of tackling the enemy with the Paris Green mixture came into vogue, we have heard much less of potato bug poisoning.

THE USE OF PARIS GREEN.

The question as to the safety and advisability of the use of this mineral in counteracting the ravages of the Colorado Potato-beetle and of other noxious insects, was revived during the year by the reading of a paper before the National Academy of Science, by Dr. J. L. LeConte, of Philadelphia, "On the use of mineral poisons for the protection of Agriculture." After some introductory remarks the paper closed with the following passages:

But in the interests of those to come after us, and for whom, rather than for ourselves, we wish to preserve the results of our labors, I do solemnly protest against the loose manner in which, on the recommendation of persons who have observed only the effects of these poisons upon the insect pests to which their attention has been directed, a most dangerous substance has been placed in the hands of a large mass of uneducated men. You will learn from those who will supplement these remarks the fearful extent to which the manufacture of this poison has increased upon agricultural demand. I can say, on the authority of a friend residing in one of the great agricultural centers of the West, that the druggists of his town order it by the ton.

The ravages of the Colorado Potato-beetle, which has been the chief agent in introducing Paris Green into agriculture, commenced in the West many years ago, and its extension, at a regular rate, was predicted by entomologists, whose opinion was worthy to be received.

The prediction has been verified almost to a year.

Now it was within the power of the Government, through a properly organized scientific bureau for the protection of agriculture, to have ordered a commission, who would, after thoroughly investigating the subject, recommend proper measures to be adopted. I am free to say that the use of metallic poisons would not be one of them. But human labor, properly compensated and intelligently employed to avert a national calamity, such as has come upon us from the incursion of the insect, might, perhaps, have been one of the agents suggested.

In a discourse before the American Association for the advancement of science, at Portland, Maine, in August, 1873, I recommended, among other measures for the promotion of economic entomology in the United States, the reorganization of the Department of Agriculture on a scientific basis for the proper protection and advancement of agriculture.

This recommendation was made the basis for several efforts on the part of the farmers of the Mississippi Valley. But, as is usual in cases where the emoluments of office and the expenditure of public funds are at stake, the attempt at reform failed. I now appeal—and trust to your influence to give the appeal as wide a circulation as possible—to the whole of the intelligent community of the country to stop this indiscriminate use of metallic poisons on the soil until the whole subject has been investigated, not by observers of the habits of insects, but by a properly constituted scientific commission of chemists, physiologists and entomologists, who will recommend a general system of attack upon our insect enemies without danger to our future agricultural prosperity.

The food-producers have not been strong enough to effect the much needed reform. Let the food-consumers now unite with them in demanding it.

The paper, which was discussed by several eminent scientists, then and there present, who conjured up all the possible cases of poisoning from Paris Green they could think of, in its careless handling, use in coloring wall paper, etc., provoked the following resolution :

Resolved, That a committee be appointed to investigate and report upon the subject of the use of poisons applied to vegetables or otherwise for the destruction of deleterious insects and other animals, and also the incautious use of poisons in the ornamentation of articles of food and destructive purposes generally, such, for instance, as the coloring of paper.

No one can hold that eminent entomologist, Dr. J. L. LeConte, in higher esteem than does the writer; and so just and to the point do I deem the remarks about our Department of Agriculture that I make place for them in full. Yet the position assumed regarding the use of Paris Green places my friend in the attitude of an alarmist, and subsequent writers, prone to exaggerate, have played upon the tocsin sounded by him till pictures of suffering and death from the use of the mineral; of the earth poisoned with it and sown with danger, are conjured up *ad libitum*. Quoth the Utica (N. Y.) *Herald*: "The eye of science sees the horrible spectre of the demon bug stalking over the patch where its body was struck down by the deadly Paris Green, and laughing in fiendish glee over the terrible retribution that awaits its slayer. * * * The chemical possibilities which may result in the poisoning of the vegetation raised from the poisoned soil are fearful to contemplate!" While, therefore, Dr. LeConte's object—which was evidently to cause more thorough experiments and investigations to be made than had hitherto been made—was praiseworthy enough, I consider the attitude assumed neither commendable nor tenable; first, because it takes no account of an extensive past experience; second, because it is contrary to that experience, and what experiment had already been made.

The subject is one of vast importance, and as it was my lot to be, perhaps, as instrumental as any one in causing the now general use of Paris Green, both for the Colorado Potato-beetle and for the Cotton-worm, I take pleasure in presenting the facts in the case, so far as they are known; for these facts will serve to dissipate much misapprehension, and certainly support the opinion previously expressed on the subject in these reports :*

Past Experience.—In the early history of the use of this mineral as an insecticide, most persons, myself included, were loth, on theoretical grounds, to recommend its general use ; and I have ever insisted that the many other mechanical and preventive measures, which, if persistently employed, are sufficient to defeat the foe, should be resorted to in preference. But the more diluted form and improved methods now-a-days employed in using the poison, render it a much safer remedy than it was a few years back; and no one should fail to take into account that during the past six years millions of bushels of potatoes have been raised, the leaves of which have been most thoroughly sprinkled with the Paris Green mixture, without any injurious effect to the tuber, or to persons using potatoes raised in this manner. Indeed, scarcely any potatoes have been raised in the Middle States during these years, without its use; yet I have to learn of the first authentic case of poisoning or injury whatever, except through carelessness and exposure to its direct influence. So far as experience

* We hear many fears expressed that this poison may be washed into the soil, absorbed by the rootlets, and thus poison the tubers; but persons who entertain such fears forget that they themselves often apply to the ground, as nourishment for the vines, either animal, vegetable or mineral substances that are nauseous, or even poisonous to us. Animal and vegetable substances, of whatsoever nature, must be essentially changed in character and rendered harmless before they can be converted into healthy tubers, and a mineral poison could only do harm by being taken with the potatoes to the table. That any substance, sprinkled either on the vines or on the ground, would ever accompany to the table a vegetable which develops underground, and which is always well cooked before use, is rendered highly improbable. There can be no danger in the use of sound tubers. But the wise and well-informed cultivator will seldom need to have recourse to Paris Green, as he will find it more profitable to use the different preventive measures that have, from time to time, been recommended in these columns.

The poison may do harm, however, by being carelessly used, and it is most safely applied when attached to the end of a stick several feet long, and should not be used where children are likely to play.—[3d Rep., pp. 99-100.

Some persons have even imagined that potatoes grown on land where it has been used are often watery, rank and of bad flavor, and according to the Monthly Report from the Department of Agriculture for August and September last, peas planted in soil mixed with the green rotted immediately and would not germinate, while those in unadulterated soil grew finely and flourished, but died immediately when transplanted into the soil mixed with the Green. How far these statements are to be relied on, each one must judge for himself, but it is certainly advisable to avoid as much as possible the use of the poison, by carrying out the other methods, both preventive and remedial, advocated in previous Reports; for wholesale remedies always have the disadvantage of destroying some friends with the foes, and in this case the true parasites and those cannibals which by mastication partake bodily of their green-covered prey, certainly fall in the general slaughter. But this remedy has now been so extensively used with good results and without any apparent harm to the tubers, that full and thorough proof against it will be necessary to cause its abandonment. Properly mixed I have used it without the slightest trace of evil effect on the leaves or tubers, and I know hundreds of others who have done likewise; so that with present experience I should not hesitate to recommend its judicious use. What is wanted on this subject, is a long series of thoroughly accurate and reliable experiments. Let our Agricultural Colleges make them! Meanwhile Paris Green will be extensively used, especially while the vines are young and most need protection; for after the expense of preparing the land and planting has been incurred, it will not do to get discouraged and abandon the field to the enemy, when such an efficient remedy is at hand.—[4th Rep., pp. 11-12.

goes, therefore, there is nothing to fear from the judicious use of the mineral. Let us then consider, from the best authority, what are the effects of its use as at present recommended: First, on the plant itself; second, on the soil; third, on man, indirectly, either through the soil or through the plant.

Its Influence on the Plant.—Practically the effect of sprinkling a plant with Paris Green, will depend very much on the amount used and on the character of the plant treated. Thus, from experiments which I made in 1872, a thorough coating of a mixture of one part of Green to fifteen of flour, while injuring some of the leaves of peas, clover and sassafras, had no injurious effect on young oaks, maples and hickories, or on cabbage and strawberries; while the fact has long been known that when used too strong and copiously it destroys potato vines. It is for this reason that the experiments made during the past year on beets, by a committee appointed by the Potomac Fruit Grower's Society, are of little value, as against the universal experience of the farmers of the Mississippi Valley. The mixture used by the committee, and which they call "highly diluted," consisted of one part of Green with but six of the dilutent, instead of from twenty-five to thirty parts of the latter; and it is no wonder that, as reported by the committee, the vitality of the plants was seriously impaired. There can be no question, therefore, about the injurious effect of the Green upon potato vines, when it is used pure or but slightly diluted; yet in this case, since it is the office of the leaves to expire rather than inspire, we cannot say that the plant is injured, or killed by absorption, any more than if it were injured or killed by hot water, which, according to the degree to which it is heated, or the copiousness of the application, may either be used with impunity or with fatal effects. Indeed, judging from my own experience, I very much incline to believe that future careful experiments will show that injury to the leaf by the application of this compound, arises more often from the stoppage of the stoma, which is effected as much by the dilutent as by the arsenite itself. So much for the influence of the poison when coming in contact with the plant above ground. The question as to how it affects the plant below ground, through the roots, may be considered in connection with—

Its Influence on the Soil.—As Prof. J. W. Johnson, in an admirable review of this subject, has recently stated:* "One pound of pure Paris Green contains about ten ounces of white arsenic, and about four ounces of copper;" or, to state it in the usual way, Sweinfurt or *pure* Paris Green contains fifty-eight per cent. of arsenious

* New York Weekly Tribune, December 16, 1874.

acid. One pound of the Green uniformly spread over an acre of soil, would amount to sixteen-hundredths of a grain per square foot, or nine-hundredths of a grain of arsenious acid. If uniformly mixed with the soil to the depth of a foot, it would, of course, be the same to the cubic foot. In actual practice, even this amount does not reach the soil direct or in an unchanged form, since much of it is acted upon by the digestive organs of the fated insects. It is safe to say that even if the Green retained for all time its poisonous power and purity in the soil, this mere fractional part of a grain might be added annually for half a century without any serious effects to the plants. In reality, however, there is no reason to believe that it does so remain. Of the few experiments on record which bear on this point, those made by Prof. W. K. Kedzie, while connected with the Michigan Agricultural College, in 1872, are the most interesting and instructive. In a paper read before the Natural History Society of the College, he proved, from these experiments, that where water was charged with carbonic acid or ammonia, a certain portion of the Green was dissolved, but was quickly converted into an insoluble and harmless precipitate with the oxide of iron which exists very generally in soils. Fleck has shown (Zeitschrift für Biologie, Bd. viii, s. 455, 1872) that arsenious acid in contact with moist organic substances, especially starch sizing, forms arseniuretted hydrogen, which diffuses in the air; and it is more than probable that the Green used in our fields will lose its poisonous power, and disappear in these and other ways. The question as to how the plant is affected by the poison through the soil is, therefore, partly answered by the above facts. Water is both the universal solvent and the vehicle by which all plants appropriate their nourishment; but in this instance its solvent and carrying power is for the most part neutralized by the oxide of iron in the soil; and though some experiments by Dr. E. W. Davy, and quoted by Prof. Johnson in the article already cited, would indicate that, under certain circumstances, some of the arsenious acid may be taken up by plants before passing into the insoluble combination; yet the quantity is evidently very slight.

Some persons have imagined that the soggy and watery potatoes that have been so common of late years are due to the influence of this poison; but this idea is proved to be erroneous by the fact that such imperfect potatoes are not confined to the districts where Paris Green has been used. Indeed, they are much more likely due to the injury and defoliation of the plant by the insect; for no plant can mature a healthy root when its leaf system is so seriously impaired by the constant gnawings of insects. Finally, we must not forget that both arsenic and copper are widely distributed throughout the inorganic world* and are found naturally in many plants; and so far from injuring plants, in minute quantities, arsenic occurs in the best superphosphates and the volcanic soil around Naples, which, like all volcanic soils, contains an unusual amount of it, has the reputation of being a specific against fungoid diseases in plants. A certain quantity may therefore be beneficial to plants, as it appears to be to animals, since horses fed on a grain or two a day are said to thrive and grow fat.†

Its Influence on Man indirectly through the Soil or through the Plant.—The Green as now used could not well collect in sufficient quantities to be directly deleterious to man in the field in any imaginable way; while its injury through the plant is, I think, out of the question; for the plant could not absorb enough without being killed. The idea that the earth is being sown with death by those who fight the Colorado Potato-beetle with this mineral, may, therefore, be dismissed as a pure phantasmagoria.

In conclusion, while no one denies the danger attending the careless use of Paris Green, and all who have recommended its use have not hesitated to caution against such carelessness, a careful inquiry into the facts from the experimental side bears out the results of a long and extensive experience among the farmers of the country—viz: that there is no present or future danger from its judicious use, in the diluted form, whether as liquid or powder, in which it is now universally recommended. Nor is the wholesale charge made by Dr. LeConte that the remedy has been recommended by persons who have observed only the effects of the poison on the insects to which their attention has been directed, warranted by the facts. It is in this as in so many other things, a proper use of the poison has proved, and will prove in future, a great blessing to the country, where its abuse can only be followed by evil consequences. Poison is only a relative term and that which is most virulent in large quantities is oftentimes harmless or even beneficial to animal economy in smaller amounts. The farmers will look forward with intense interest to the work of the committee appointed by the National Academy, or of any national commission appointed to investigate the subject, and will hail with

* Prof. Johnson, (*loc. cit.*) writes:

The wide distribution of both arsenic and copper is well known to mineralogists and chemists. These metals are dissolved in the waters of many famous mineral springs, as those of Vichy and Wiesbaden. Prof. Hardin found in the Rockbridge Alum Springs of Virginia, arsenic, antimony, lead, copper, zinc, cobalt, nickel, manganese, and iron. The arsenic, however, was present in exceedingly minute quantity. Even river water, as that of the Nile, contains an appreciable quantity of arsenic. Dr. Will, the successor of Liebig at Giessen, proved the existence of five poisonous metals in the water of the celebrated mineral springs of Rippoldsau, in Baden. In the Joseph's Spring he found to 10,000,000 parts of water arsenic (white,) 6 parts; tin oxide, 1-4 part; antimony oxide, 1-6 part; lead oxide. 1-4 part; copper oxide, 1 part. Arsenic and copper have been found in a multitude of iron ores, in the sediments from chalybeate springs, in clays, marls and cultivated soils. But we do not hear that the arsenic thus widely distributed in waters and soils ever accumulates in plant or animal to a deleterious extent.

† See an article on "Arsenic in Agricultural and Technical Products," by Prof. A. Vogel, in *Scientific American*, Oct. 17, 1874.

joy and gratitude any less dangerous remedy that will prove as effectual; but until such is discovered, they will continue to use that which has saved them so much labor and given so much satisfaction. I would therefore say to those agriculturists of the East who are in any way alarmed by what has been written on this subject, and who hesitate to use the Paris Green mixture—profit by the experience of your more western brethren, and do not allow the voracious Doryphora to destroy your potatoes, when so simple and cheap a remedy is at hand!

THE BEETLE EATS AS WELL AS THE LARVA.

As the statement has been quite frequently made during the year, in Eastern papers, that the beetle does not feed, and that consequently there is nothing to fear from them early in the year, the fact may as well be reiterated that the beetle does feed, though not quite so ravenously as the larva. But as they are on hand as soon as the young plants peep through the ground, and as these first spring beetles are the source of all the trouble that follows later in the season, it is very important to seek and destroy them.

IT PASSES THE WINTER IN THE BEETLE STATE.

The statement is continually made that the insect hibernates as a larva. "I must insist that with us it never does, but that the last brood invariably hibernates in the perfect beetle state. Specimens have been found at a depth of eight and even ten feet below the surface, but the great majority do not descend beyond eighteen or twenty inches, and many will not enter the ground at all if they can find other substances above ground that will shelter them sufficiently. The beetles are found abundantly above the ground in the month of April in the latitude of St. Louis, but often re-enter it after they have once left, especially during cold, damp weather."—[4th Report.

NEW FOOD PLANTS.

Mr. A. W. Hoffmeister, of Ft. Madison, Iowa, an entomologist, the accuracy of whose observations may be relied on, writes:

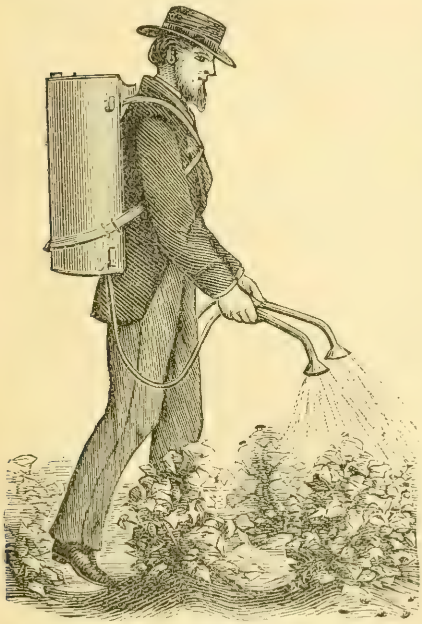
Last year, after all the early potatoes had been taken up and the late ones either wilted through excessive dryness or eaten up by the Colorado gentleman, I was astonished to find so many 10-lined spearmen in the lower part of town, while in the upper part they were reasonably scarce; but I was more astonished to find that the larvæ had stripped the *Verbascum* of its leaves.

The Mullein, belonging to the Figwort family, must therefore be added to the list of plants on which the insect lives and flourishes. An item went the rounds of the papers during the year to the effect that alfalfa is greedily devoured by this insect, but just how much credit should be given to the statement, which originated with a Montana correspondent of the *Farmer's Home Journal* of Kentucky, it is difficult to say. Probably the reference was originally made to the old-fashioned "potato-bugs," or blister-beetles, which are common in the Western country and very general feeders.

NEW MEANS OF DESTRUCTION.

The use of Paris Green having become a universal remedy for this pest, there is little to be said under this head, except as regards the improved methods of using the application. Last spring, Mr. Frank M. Gray of Jefferson, Cook county, Ills., sent me a sprinkler which he has constructed for sprinkling two rows at once. It is so simple and yet so useful that a brief description of it will not be out of place here. It consists of a can capable of holding about eight gallons of liquid, and so formed as to rest easily on the back, to which it is fastened, knapsack fashion, by adjustable straps, which reach over the shoulders and fasten across the breast. To the lower part of the can are attached two rubber tubes which are connected with two nozzles on sprinklers. The inside of the can has three shelves which help to keep the mixture stirred. There is a convenient lever at the bottom which presses the tubes and shuts off the outflow at will, and two hooks on the sides near the top on which to hang the tubes when not in use. On the top is a small air-tube and a capped orifice. Two bucketfulls of water are first poured into the can, then three tablespoonfulls of good Green, well mixed with another half-bucketfull of woter and strained through a funnel-shaped strainer which accompanies the machine, and the use of which prevents the larger particles of the Green from getting into the can and clogging up the sprinklers. Five to eight acres a day can readily be sprinkled by one man using the can, and from one to one and a half pounds of good Green, according to the size of the plants

[Fig. 1.]



Gray's Improved Sprinkler, for the use of Paris Green water.

will suffice to the acre. Two lengths of nozzles are furnished, one for use when the plants are small, the other when they are larger. The can should be filled on the ground and then raised on a bench or barrel, from which it is easily attached to the back. The walking serves to keep the Green well shaken, and the flow of liquid is regulated at will by a pressure of the fingers at the junction of the tubes with the metallic nozzles. When not in use, the tubes should be removed and the can emptied and laid on its back. I can testify to the ease and efficiency with which this little machine may be used, and it has been so well thought of that it is now manufactured and for sale at 66 W. Madison street, Chicago, though I do not know at what price.

THE PROPER SCIENTIFIC NAME OF THE BEETLE.

Of course the American reader need not be informed of the fact that this insect has been universally known, since it attained popular notoriety, by the scientific name of *Doryphora* 10-*lineata* Say. American coleopterists have from the first been fully aware that it differed from the typical genus *Doryphora* in lacking the point produced on the mesosternum (middle of breast), which is characteristic of that genus as defined by its founder, Olivier. Yet as this character is of secondary importance, and by no means of generic value, in many other families of Coleoptera; and our insect in other characters, and especially in the short and transverse form of the maxillary palpi, approaches nearer to the genus *Doryphora* than to any other genus of its sub-family (*Chrysomelides*), that father of American Entomology, Thomas Say, described it under that genus. Subsequent American authorities, including Dr. LeConte, have followed this enlarged definition of the genus *Doryphora*, considering the palpial of much more value than the sternal characters; and Say's name has consequently been universally adopted in this country both by popular and technical writers. The genus *Chrysomela* of Linnæus has been made the basis of several minor divisions, which are considered to be of generic value or not, according to the opinions of different systematists. Thus Melsheimer in his catalogue of N. A. Coleoptera (1853) refers our potato-beetle to the genus *Polygramma* erected by the French entomologist Chevrolat upon unimportant colorational characters. Recently, the Sweedish entomologist Stäl in a Monograph of the American Chrysomelides* erects the genus *Myocoryna*, on the slightly compressed form of the antennal club, for our potato beetle, and several other species from Texas and Mexico. Until some yet distant day when the science of entomology shall be perfected, there will be

* Trans. Sweedish Academy, 1858, p. 316.

a constant chopping and changing in generic nomenclature (much of it of questionable warrant or advantage), and it is ofttimes preferable, especially in popular works, to anchor to the more comprehensive and better known generic terms, instead of confounding the reader by the more recent changes. There is nothing to prevent any author from erecting new genera, but whether a proposed genus is in the end by common consent adopted or not will depend on the value of the characters on which it is founded. Our best authorities ignore the more recent divisions, and LeConte writes me: "Let us set our faces against the adoption of the multitude of genera, which even the founders fail to sustain. * * * Let *Polygramma*, *Leptinotarsa*, *Myocoryna*,* etc., never be mentioned amongst us." Thence, if we write *Chrysomela* 10-*lineata* (Say), with Crotch, in his list of N. A. Coleoptera (1873), we indicate that in our opinion the later divisions into which that genus has been broken up, and which would include this species, are not based on sufficiently important and distinctive characters; if we write *Doryphora* 10-*lineata* Say, we express our belief in the generic value of the palpial characters. In either event no confusion will ensue providing the authority for the species is given, and the American entomologist does no violence either to good sense or propriety by designating the insect as it was at first described, i. e., *Doryphora* 10-*lineata*. It is because of the present unsettled conditon of entomological nomenclature that the custom yet prevails of attaching the abbreviated authority to the names of insects, as the only sure way to express our meaning and obviate all confusion as to the species intended.

I have been led to these synonymical remarks by an article by M. E. A. Carrière, which, had it occurred in a less important journal than the *Revue Horticole*,† of which he is editor, would not deserve notice. With an arrogance in keeping with the superficial knowledge of the subject he displays, M. Carrière undertakes to read the Americans an entomological lesson, teach them how to correctly designate this potato enemy and "cut short the confusion" which he takes it for granted exists on the subject in this country. As the idea is altogether too prevalent among European writers that American naturalists are a set of know-nothings, I shall briefly notice this article of M. Carrière's to show how ridiculously pragmatical he appears in

* Even if the characters given by Stål are ever considered by authors generally of generic value, the name *Myocoryna* could not be employed, as it is preoccupied by a genus, in the same family of Chrysomelians, founded by Dejean (Cat. 3d edit., p. 428); and if our potato-beetle is to be known by any subgeneric title I would propose that of *Thlibocoryna*.

† Subsequently noticed in several European periodicals, and republished in the *Journal d' Agriculture Pratique*, and in the Bulletin of the *Soc. Centrale d' Agr. du Dep. de l' Hérault*, 1874, pp. 84-5.

the eyes of those whom he attempts to teach, however much his show of erudition may awe his French readers.

First, then, we are informed that our insect should be referred to the genus *Chrysomela*, or else—admitting the subdivisions of that genus—to the sub-genus *Polygramma* of Chevrolat. Considering that before M. Carrière wrote, Crotch had made the former reference, and Melsheimer many years previously, the second—this information is not novel.

Secondly, we are gravely told that another error "more difficult to comprehend, because it is pure nonsense," consists in calling the insect by the specific name of *decempunctata!* Since no American entomologist has ever called it by that name, and it was first so designated in a foreign journal, by mistake, M. Carrière might have saved himself the exhaustive effort to comprehend it.

Thirdly, M. Carrière considers the *juncta* of Germar as a synonym of 10-*lineata* Say, a thing which no entomologist at all informed would think of doing to-day, after the characters of the two have been so well defined in this country.

Fourthly, he undertakes to define this amalgamated species, and does it in so bungling a way that only general characters are given, and the most distinctive features omitted. Yet with complacency he speaks of this definition as "these details which we have deemed necessary to particularize and firmly establish the identity and the character of *C. decemlineata!!*"

Fifthly, we are gravely informed that our beetle is not a fly (*mouche*)—most interesting information, since no one in America calls it a "fly."

Sixthly, we are told that *Colorado* is the vulgar name for the insect—a statement which shows that its author is as good a geographer as he is entomologist. He then declares that no remedy has been discovered "for that which is employed is no less redoubtable than the evil itself;" ridicules (as do all who have no proper knowledge of the important part played by parasitic and predaceous insects in keeping the vegetable feeders in check) the idea of benefit to man from predaceous insects; and closes by recommending certain remedies, which have been proved useless here and are the conceptions of inexperience.

Such are some of the more glaring errors in this production of a gentleman who plays the role of instructor to the American entomologists. In short, instead of deriving his information from trustworthy sources, and ascertaining what had really been written by Americans on this subject, as every cautious critic would have done, M. Carrière gets all he possessed at second hand from the poor translations, in certain London journals, of Col. F. Hecker's communication to the *Gartenlaube*, which I referred to in my Sixth Report (p. 15). He thus lances his criticisms at imaginary errors, and in attempting to be deep becomes extremely shallow.

THE CHINCH BUG—*Micropus leucopterus* (Say).

(Subord. HETEROPTERA; Fam. LYGÆIDÆ.)

Never, perhaps, in the history of the country, and certainly never in the history of the State of Missouri, was the Chinch Bug so disastrous in its work as during the year 1874. This fact is explained in part by the very dry weather which prevailed during early summer in the Northwestern States—weather favorable to the insect's well-being and multiplication—but was also greatly due to the very dry Fall of 1873 and the following comparatively mild and dry Winter; conditions that permitted the survival of an unusually large number of the bugs, which dispersed over our fields in the spring and gave birth to myriad young, which throve and prospered amazingly. In order to gather as complete statistics as possible about this insect in Missouri, I sent the following questions to several prominent farmers in every county in the State:

1. How far back in the history of your county has this insect (the Chinch Bug) been known to injure the grain and grass crops?

2. What crops have suffered most from its ravages?

3. Have any systematic efforts ever been made to overcome its injuries; and have you any idea to what extent my Second Report—which contained what was known about the insect up to that time, and which was bound in with the Fifth (1869) State Agricultural Report—is distributed or known of among the farmers of your county?

4. Give approximately this year's estimated damage in your county, by this single insect—all crops affected by it considered.

Replies to these questions have been received from nearly every county, and I am under obligations to the many gentlemen throughout the State who have thus assisted me. To publish these replies in full would occupy altogether too much space, and would be unnecessary; yet, as there is much valuable experience contained in them, I have brought together such parts as will most generally interest the farmers of the State, in an Appendix at the end of this article.

It will be seen that the replies to the third question are almost unanimous to the effect that little or nothing is known or has been seen of the Second Entomological Report; and it is for this reason and from the number of letters of inquiry about the insect that reached me about harvest time last Summer, that I deem it advisable to give a full account of the Chinch Bug in the present volume, reproducing, in quotation marks, portions of the article referred to in the Second Report.

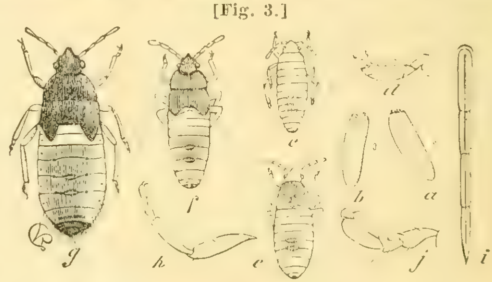
APPEARANCE AND TRANSFORMATIONS OF THE CHINCH BUG.

[Fig. 2.]

CHINCH BUG: Hair line underneath showing natural size.

Few farmers in this section of the country need an introduction to this insect; but lest there be those who are so blessed as not to know the gentleman by sight, I annex his portrait. Known to science as *Micropus leucopterus*, he belongs to the Half-wing Bugs (*Heteroptera*,) the same sub-order to which a well known bed pest belongs, and he exhales the same most disagreeable odor. He subsists by sucking with his sharp pointed beak (Fig. 3, *i*) the grasses and cereals, thereby causing them to shrink, wilt and wither—and not by biting their substance as many persons suppose. Like the other species of its sub-order, it undergoes no very sudden transformations. Born as a little pale yellow 6-legged atom, scarcely visible to the naked eye, and with a tinge of red near the middle of the body, (Fig. 3, *c*,) it goes through four molts before acquiring wings. It is bright red, with a pale band across the middle of the body after the first; somewhat darker with the merest rudiments of wing-pads after the second, and quite brown, with distinct wing-pads, but with the pale transverse band still visible, after the third, in which it assumes the pupa state, and from which, in the fourth molt, it escapes as a winged bug.

[Fig. 3.]



IMMATURE STAGES OF CHINCH BUG:—*a*, *b*, eggs; *c*, newly-hatched larva; *d*, its tarsus; *e*, larva after first molt; *f*, same after second molt; *g*, pupa—the natural sizes indicated at sides; *h*, enlarged leg of perfect bug; *j*, tarsus of same still more enlarged; *i*, proboscis or beak, enlarged.

[Fig. 4.]

SHORT-WINGED CHINCH BUG.

"There are, as is well known to entomologists, many genera of the Half-winged Bugs, which in Europe occur in two distinct or "dimorphous" forms, with no intermediate grades between the two; namely, a short-winged or sometimes even a completely wingless type and a long-winged type. Frequently the two occur promiscuously together, and are found promiscuously copulating so that they cannot posibly be distinct species. Sometimes the long-winged type occurs in particular seasons, and especially in very hot seasons. More rarely the short-winged type occurs in a different locality from the long-winged type, and usually in that case in a more northerly locality. We have a good illustration of this latter peculiarity in the case of the Chinch Bug, for a dimorphous short-winged form occurs in Canada, and Dr. Fitch describes it from specimens received from the States, as a variety, under the name of *apterus*."

DESCRIPTIVE.

MICROPUS LEUCOPTERUS (Say.)—*Egg*—Average length 0.03 inch, elongate-oval, the diameter scarcely 1-5 the length. The top squarely docked and surmounted with four small rounded tubercles near the center. Color, when newly laid, pale or whitish, and translucent, acquiring with age an amber color, and finally showing the red parts of the embryo, and especially the eyes toward tubercled end. The size increases somewhat after deposition, and will sometimes reach near 0.04 inch in length.*

Larval Stages.—The newly hatched larva is pale yellow, with simply an orange stain on the middle of the three larger abdominal joints. The form scarcely differs from that of the mature bug, being but slightly more elongate; but the tarsi have but two joints (Fig. 4, *d*,) and the head is relatively broader and more rounded, while the joints of body are sub-equal, the prothoracic joint being but slightly longer than any of the rest. The red color soon pervades the whole body, except the first two abdominal joints, which remain yellowish, and the members, which remain pale. *After the first molt* the red is quite bright vermillion, contrasting strongly with the pale band across the middle of the body, the prothoracic joint is relatively longer, and the metathoracic shorter. The head and prothorax are dusky and coriaceous, and two broad marks on mesothorax, two smaller ones on metathorax, two on the fourth and fifth abdominal sutures, and one at tip of abdomen are generally visible, but sometimes obsolete; the third and fourth joints of antennæ are dusky, but the legs still pale. *After the second molt* the head and thorax are quite dusky, and the abdomen duller red, but the pale transverse band is still distinct; the wing-pads become apparent, the members are more dusky, there is a dark red shade on the fourth and fifth abdominal joint, and, ventrally, a distinct circular dusky spot covering the last three joints.

Pupa—In the pupa all the coriaceous parts are brown-black, the wing-pads extend almost across the two pale abdominal joints which are now more dingy, while the general color of the abdomen is dingy gray; the body above is slightly pubescent, the members are colored as in the mature bug, the three-jointed tarsus is foreshadowed, and the dark horny spots at tip of abdomen, both above and below, are larger.

Imago—The perfect insect has been well described, and I will append the original descriptions:

LYGÆUS LENCOPTERUS (chinch bug). Blackish, hemelytra white with a black spot. Inhabits Virginia.

Body long, blackish, with numerous hairs. Antennæ, rather short hairs; second joint yellowish, longer than the third; ultimate joint rather longer than the second, thickest; thorax tinged with cinereous before, with the basal edge piceous; hemelytra white, with a blackish oval spot on the lateral middle; rostrum and feet honey yellow; thighs a little dilated.

Length less than three-twentieths of an inch.

I took a single specimen on the eastern shore of Virginia.

The whiteness of the hemelytra, in which is a blackish spot strongly contrasted, distinguishes this species readily—[Say, Am. Entomology, I, p. 329.

*This last is the length given by Dr. Shimer. The stricture on this measurement in my 2d Report (p. 22,) first appeared in the *American Entomologist*, in an editorial prepared principally by Mr. Walsh, and was made without having measured the egg.

The above description originally appeared in 1832, in a pamphlet entitled "Descriptions of new species of Heterocerous Hemiptera of N. A."

Length 1⅗ lines, or three-twentieths of an inch. Body black, clothed with a very fine grayish down, not distinctly visible to the naked eye; basal joint of the antennæ honey yellow; second joint of the same tipt with black; third and fourth joints black; beak brown; wings and wing-cases white; the latter are black at their insertion, and have near the middle two short irregular black lines, and a conspicuous black marginal spot; legs dark honey yellow, terminal joint of the feet, and the claws black.—[Dr. Wm. LeBaron in the *Prairie Farmer* for September, 1850, vol. x, pp. 280, 281, where the name of *Rhyparochromus devastator* is proposed for it.

Dr. Fitch also enumerates the following varieties of this insect:

a, *immarginatus*. Basal margin of the thorax not edged with yellowish. Common.

b, *dimidiatus*. Basal half of the thorax deep velvety black, anterior half grayish. Common.

c, *fulvivenosus*. The stripes on the wing covers tawny yellow instead of black.

d, *albivenosus*. Wing covers white, without any black marks except the marginal spot. A male.

e, *apterus*. Wingless and the wing covers much shorter than the abdomen.

f, *basalis*. Basal joint of the antennæ dusky and darker than the second.

g, *nigricornis*. Two first joints of the antennæ blackish.

h, *femoratus*. Legs pale livid yellow, the thighs tawny red. Common.

i, *rufipedis*. Legs dark tawny red or reddish brown.

To these varieties, all of which occur with us, I would add one which may be known as *melanosus*, in which the normal white of the wings is quite dusky, and contains additional black marks at base and toward tip, and in which all the members and the body except the rufous hind edge of thorax are jet black.

PAST HISTORY OF THE CHINCH BUG.

"The first record we have of the prevalence of the Chinch Bug was in the old Revolutionary times in North Carolina, where it was confounded with the Hessian Fly, an insect just then imported from Europe into the United States. Ever since those times it has been an epidemic pest, in particular years, in North and South Carolina and in Virginia. The great American entomologist, Thomas Say, in 1831, when he had been residing in Indiana for six years, was the first to name and describe it scientifically. He states that he 'took a single specimen on the Eastern shore of Virginia;' whence we may reasonably infer that it was then either unknown or very rare in Indiana, and probably also in other Western States."

PAST HISTORY OF THE CHINCH BUG IN MISSOURI.

In the Appendix will be found records of this insect as far back as 1836 in two counties in Missouri. W. D. Palson, of Southwest City, McDonald county, writes: "I have been here ever since 1836, and have seen the bugs ever since I could recollect, but never knew what they were until 1873." D. P. Dyer, of Warrenton, Warren county, also speaks of their appearance during the same year. No very serious damage was however done at this time by the insect, and not until 1844 are any complaints made. From this time it gradually increased in numbers, and during the summers of 1854, 55, 56, 57 and 59 did much damage to all kinds of cereals and grasses. In 1866 they were quite bad and also in 1870 and 1871, while during the dry years of 1872 and 1873, they spread pretty much all over the State and were injurious in counties like Scott, Greene and Mississippi, where they had scarcely been noticed before.

"We may safely conclude that the Chinch Bug has always existed in Missouri, in small numbers; but that it did not multiply to an injurious extent until the grains began to be cultivated on an extensive scale. At all events, we know from the evidence of Dr. Harris and Dr. Fitch, that it existed long ago in exceedingly small numbers in New York, and even in Massachusetts. What the causes may have been that thinned out the numbers of this insect in former times in the West, is another question. In former times, the great bulk of these bugs were probably destroyed every winter by the prairie fires, and, as cultivation has extended in consequence of the country being gradually settled up, and less and less prairie has been annually burnt over, the number that has survived through the winter to start the next year's broods has annually become greater. If these views be correct, we may expect them, unless more pains be taken to counterwork and destroy them, to become, on the average of years, still more abundant than they now are, whenever prairie fires shall have become an obsolete institution; until at last Western farmers will be compelled, as those of North Carolina have already several times been compelled, to quit growing wheat altogether for a term of years.

"It may be very reasonably asked, why the Chinch Bug does not increase and multiply in Massachusetts and New York, seeing that it existed there long ago, and that there are, of course, no prairie fires in those States to keep it in check. The answer is, that the Chinch Bug is a Southern, not a Northern species; and that hundreds of Southern species of insects, which on the Atlantic seaboard only occur in southerly latitudes, are found in profusion in quite a high latitude in the Valley of the Mississippi. The same law, as has been observed by Professor Baird, holds good both with Birds and with Fishes."*

The Chinch Bug will, also, for reasons which will presently be made apparent, naturally thrive less in the moister climate of the New England States. Again we may very naturally infer that the more cleanly and careful system of culture, and the more general use of the roller in the older States have had much to do with the comparative immunity they enjoy. I am also of the opinion that it will

*Silliman's Journal, XLI, p. 87.

not multiply as much on a sandy as on a clayey loam, for the reason that it cannot move about as readily in such a soil; and the immunity of grain immediately along the Missouri river in Cole county, attested by Mr. N. DeWyl and others, is, I think, more due to the sandy nature of the soil, compared to that farther back of the river, than to the greater moisture in the immediate vicinity of the river.

DESTRUCTIVE POWERS OF THE CHINCH BUG.

Though but one of the many insect pests that afflict the farmer, it is, perhaps, all things considered, the most grievous. Few persons who have not paid especial attention to the subject have any just conception of the amount of damage the Chinch Bug sometimes inflicts, and many will be surprised to learn that, setting aside the injury done to corn, the loss which the little scamp occasioned to the small grains in the Northwestern States in 1871, amounted to upwards of thirty million dollars, at the very lowest estimates—as proved by careful computations made by Dr. LeBaron in his Second Annual Report as State Entomologist of Illinois. The loss in 1874 may safely be put down at double that sum. Indeed, not even the migratory locusts that, from time to time, spread devastation over the western country can be compared in destructiveness to this little bug; for his devastations, though not so general, are more incessant, and cover a more thickly settled range of country. Those who have not seen the ground alive and red with its young, or the plants black with the dark bodies of the more mature individuals; those who have not seen the stout cornstalk bow and wilt in a few hours from the suction of their congregated beaks, or a wheat field in two or three days rendered unfit for the reaper; those who have never seen the insect marching in solid phalanx from field to field, or absolutely filling the air for miles —can form no adequate conception of its destructive powers! It is no wonder, therefore, that Kirby and Spence, more than half a century ago, exclaimed, in speaking of this "chintz-bug-fly," that "it seems very difficult to conceive how an insect that lives by suction, and has no mandibles, could destroy these plants so totally." *

ITS INJURIES IN 1874.

Though we have had previous bad Chinch Bug years, of which the more recent ones of 1864, 1868 and 1871 may be mentioned, yet I doubt whether in any one previous year it has occasioned such widespread destruction. Its greatest injury is usually confined to the spring wheat belt, which includes, roughly speaking, South and Central Illinois, North and Central Missouri, South Nebraska and Kansas;

* Introduction to Entomology, London, 1828, Vol. I, p. 171.

but its ravages the past year were reported over a far wider range of country, and extended south to Texas and Arkansas and east to Virginia. Even in Kentucky, where it does not usually attract much attention, Mr. John C. Noble, of Paducah, wrote me last June that the corn in the western counties was being ruined by it. Any estimates of the loss to the country at large must necessarily be crude, and the figures would foot up till they would appear incredible. I shall therefore confine myself more particularly to

ITS INJURIES IN MISSOURI IN 1874.

From the detailed county returns in the Appendix the estimated loss by counties may be stated as follows:

Adair, \$20,000; Andrew, \$140,000; Atchison, \$217,000; Barry, \$80,000; Barton, \$100,000; Bates, \$500,000; Benton, \$350,000; Buchanan, \$100,000; Butler, \$120,000; Caldwell, \$125,000; Cape Girardeau, \$40,000; Carroll, \$550,000; Cass, \$500,000; Cedar, \$278,000; Chariton, \$600,000; Christian, \$45,000; Clark, \$50,000; Clay, \$350,000; Clinton, \$300,000; Cole, \$130,000; Cooper, \$150,000; Crawford, \$90,000; Dallas, \$50,000; Daviess, \$400,000; DeKalb, \$230,000; Douglas, \$25,000; Dunklin, no bugs; Franklin, \$160,000; Gasconade, \$65,000; Gentry, \$220,000; Greene, \$300,000; Grundy, \$125,000; Harrison, \$255,000; Henry, \$600,000; Hickory, \$130,000; Holt, \$540,000; Howard, \$50,000; Iron, \$180,000; Jackson, \$450,000; Jasper, \$230,000; Johnson, \$700,000; Knox, \$30,000; Laclede, \$45,000; Lafayette, \$550,000; Lawrence, \$210,000; Lewis, \$58,000; Linn, \$160,000; Macon, \$155,000; Madison, \$27,000; Maries, \$100,000; Marion, \$90,000; Mercer, \$250,000; Mississippi, \$15,000; Monroe, \$280,000; Montgomery, \$100,000; New Madrid, \$50,000; Newton, \$85,000; Nodaway, \$100,000; Oregon, \$10,000; Osage, \$210,000; Ozark, \$40,000; Perry, \$50,000; Pettis, \$300,000; Platte, \$100,000; Polk, \$300,000; Pulaski, \$75,000; Putnam, \$100,000; Ralls, \$80,000; Randolph, \$20,000; Ray, \$250,000; Ripley, \$40,000; St. Charles, \$25,000; St. Clair, \$375,000; St. Francois, \$100,000; St. Genevieve, \$125,000; Saline, \$450,000; Scotland, \$100,000; Scott, \$50,000; Shelby, \$50,000; Sullivan, \$65,000; Taney, \$45,000; Texas, \$70,000; Vernon, \$225,000; Warren, \$120,000; Washington, \$100,000; Wright, \$60,000.

The aggregate loss from these counties foots up, therefore, to \$15,385,000. From the remaining 28 counties, either no reports have been received, or they have been too meagre to form a basis on which to estimate. Some of these counties are not thickly settled, but, estimating by the census returns for 1870, and by the counties which have reported, and which made similar returns, the loss to these 28 counties would amount to about \$3,615,000—making the total loss for the State, *nineteen million dollars!*

These calculations do not include any other than the three staple crops of wheat, corn and oats, and are based on the U. S. Census Report of 1870, and on average prices of 90c per bushel for wheat, 50c for corn and 60c for oats.

In taking no account of the increased acreage since 1870, nor of other cereals than those mentioned; and in estimating at prices below present market rates, the damage by drouth, independent of Chinch Bug, is fully offset, and the calculation must be below rather than above the mark. I am aware of the difficulty always encountered in endeavoring to get accurate crop reports and estimates; and, indeed, anything like accurate agricultural statistics is almost impossible in this country; yet the above figures cannot be far out of the way, and will certainly astonish our legislators, and even the farmers of the State, few of whom have any just conception of the vast sum this apparently insignificant little bug filches from their pockets. That the sum here given is below the actual loss will be appreciated all the more when I state that the estimated money loss through the Chinch Bug in Illinois, in 1864, was over seventy-three million dollars. The damage does not even stop here, but brings many serious indirect evils in its train. In a number of counties the farmers have not had sufficient grain to fatten their stock, and have been obliged to sell them at ruinous prices; or, hoping to bring their animals through the winter, and disappointed by its unprecedented and prolonged severity, they have seen their stock die off without power to avoid the calamity. In some counties, and especially south of the Dent county line, the distress has been so great that the Legislature was appealed to for aid in keeping the sufferers from actual starvation, but a bill appropriating $50,000 for this purpose failed to pass both Houses.

ITS FOOD PLANTS.

It may be stated as a rule, which admits of very few exceptions, that the Chinch Bug is confined to, and can subsist only on, the juices of the grasses and cereals; its original food, when the red man ruled the land, being the wild grasses.* All accounts, therefore—and such accounts are coming to me constantly—of chinch bugs injuring grape vines, potatoes, etc., are based on the error of persons who mistake for the genuine article some one or other of the species which will be presently referred to as bogus or false chinch bugs. It is true that Packard, in his "Guide to the Study of Insects," says, in speaking of the Chinch Bug, that "they also attack every description of garden vegetables, attacking principally the buds, terminal shoots, and most succulent growing parts of these and other herbaceous plants;" but this statement is the result of bad compilation, the language, which is quoted from Harris, having reference, in the original, to the Tar-

*I have found the young around the roots of strawberry plants, under circumstances which lead me to believe that they can feed upon this plant.

nished Plant Bug (*Capsus oblineatus* Say), which, as may be seen from my second report, (p. 114), really has such an omnivorous habit. Though, therefore, the subject of our present sketch is restricted to certain families of plants, yet it manifests a decided preference for some of the grains over others. Thus it shows a great predilection for Hungarian grass; while of the more important cereals it is most severe on spring wheat and barley.

MODE OF REPRODUCTION AND HIBERNATION.

"Most insects—irrespective of the Order to which they belong—require 12 months to go through the complete cycle of their changes, from the day that the egg is laid to the day when the perfect insect perishes of old age and decrepitude. A few require 3 years, as for example the Round-headed Apple-tree Borer (*Saperda bivittata* Say) and the White Grub which produces the May-beetle (*Lachnosterna quercina* Knoch.) One species, the Thirteen-year Locust (*Cicada tredecim* Riley), actually requires 13 years to pass from the egg to the winged state; and another, the Seventeen-year Locust (*Cicada septemdecim* Linn), the still longer period of 17 years. On the other hand there are not a few that pass through all their three states in a few months, or even in a few weeks; so that in one and the same year there may be 2, 3 or even 4 or 5 broods, one generated by the other and one succeeding another. For example, the Hessian Fly (*Cecidomyia destructor* Say), the common Slug-worm of the Pear (*Selandria cerasi* Peck), the Slug-worm of the Rose (*Selandria rosæ* Harris), the Apple-worm and a few others, produce exactly two generations in one year, and hence may be termed "two-brooded." Again, the Colorado Potato-beetle in Central Missouri is three-brooded, and not improbably in more southerly regions is four-brooded. Lastly, the common House-fly, the Cheese-fly, the various species of Blow-flies and Meat-flies, and the multifarious species of Plant-lice (*Aphidæ*) produce an indefinite number of successive broods in a single year, sometimes amounting, in the case of the last named genus, as has been proved by actual experiment, to as many as nine.

"As long ago as March, 1866, I published the fact that the Chinch Bug is two-brooded in North Illinois (*Practical Entomologist*, I, p. 48), and I find that it is likewise two-brooded in this State, and most probably in all the Middle States. Yet it is quite agreeable to analogy that in the more Southern States it may be three-brooded. For instance, the large Polyphemus Moth is single-brooded in the Northern and Middle States, and yet two broods are sometimes produced in this State, while in the South it is habitually two-brooded. Again, the moth known as the Poplar Spinner (*Clostera Americana* Harris), is stated by Dr. Harris and Dr. Fitch to be only single-brooded in Massachusetts and New York, the insect spinning up in September or October, passing the winter in the pupa state, and coming out in the winged form in the following June. But Dr. Harris—no doubt on the authority of Abbott—states that 'in Georgia this insect breeds twice a year;'* and I have proved that it does so breed in Missouri."

"It is these two peculiarities in the habits of the Chinch Bug, namely, first, its continuing to take food from the day of its birth to the day of its death, and, secondly, its being either two-brooded or many-brooded, that renders it so destructive and so difficult to combat. Such as survive the autumn, when the plants on the sap of which they feed are mostly dried up so as to afford them little or no nourishment, pass the winter in the usual torpid state, and always in the perfect or winged form, under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass or weeds or straw, and often in cornstalks and cornshucks.

"In the winter, all kinds of insect-devouring animals, such as birds, shrew mice, etc., are hard put to it for food, and have to search every hole and corner for their appropriate prey. But no matter how closely they may thin out the chinch bugs, or how generally those insects may have been starved out by the autumnal droughts, there will always be a few left for seed next year. Suppose that there are only 2,000 chinch bugs remaining in the spring in a certain field, and that each female of the 2,000, as vegetation starts, raises a family of only 200, which is a low calculation. Then—allowing the sexes to be equal in number, whereas in reality the females are always far more numerous than the males—the first or spring brood will consist of 200,000, of which number 100,000 will be females. Here, if the species were single-brooded, the process would stop for the current year; and 200,000 chinch bugs in one field would be thought nothing of by the Western farmer. But the species is not single-brooded, and the process does NOT stop here. Each successive brood increases in numbers in geometrical progression, unless there be something to check their increase, until the second brood amounts to twenty millions, and the third brood to two thousand millions. We may form some idea of the meaning of two thousand millions of chinch bugs when it is stated that that number of them, placed in a straight line head and tail together, would just about reach from the surface of the earth to its central point—a distance of four thousand miles."

WHERE THE EGGS ARE LAID.

The Chinch Bug deposits its eggs occasionally above ground on

* *Injurious Insects*, p. 431.

the blades of grain, but far more often, and normally, underground, upon the roots of the plants infested. These eggs are three-hundredths of an inch long, elongate-oval, pale amber-colored and with one end squarely docked off and ornamented with four little tubercles near the centre. (Fig. 3, *a.*) They are deposited in little clusters, and the young lice hatching from them are at first bright red and remain for a considerable time underground, sucking the sap from the roots. A wheat plant pulled from an infested field in the spring of the year, will generally reveal hundreds of these eggs attached to the roots, and at a somewhat later period, the young larvæ will be found clustering on the same, and looking like so many moving red atoms. As the sequence will show, it is practically quite important that we know the whereabouts these eggs are deposited; yet they are so small and so difficult of detection that the wildest theories were promulgated as to the origin and birth of chinch bugs, until the question was settled by the entomologist with his lens and microscope. The female occupies from two to three weeks in depositing her eggs; the egg requires about two weeks to hatch, and the bug becomes full-grown and acquires its wings in five or six weeks from hatching.

Individuals may be found of all sizes and ages throughout the summer months, yet the great body of the first brood mature soon after the ripening of spring wheat.

Insects generally lay all their eggs in single masses and in a comparatively brief time: in other words, the eggs in the ovaries are almost simultaneously developed, and the female devotes the last of her life to the single and comparatively brief act of oviposition, and then perishes from exhaustion. In the Chinch Bug, however, as in the Colorado Potato-beetle, Plum Curculio, etc., the ova continue to develop for several weeks, and the eggs are laid from day to day in small numbers.

FLIGHT OF THE CHINCH BUG.

Though, as we have already seen, there is a dimorphous, short-winged form, incapable of flight, and found more particularly in northern latitudes, the normal, long-winged form is abundantly able to fly, and is sometimes seen swarming in the air. This flight is most noticeable at three periods in the year. First, during the early warm days of Spring, when—issuing from their winter quarters—the individuals of the second or hibernating brood perform their courtships, and the females scatter over the wheatfields and seek the driest and most open soil, that they may penetrate to the roots of the plants and there consign their eggs. Secondly, in July, after wheat is harvested, and the great body of the first brood have acquired wings and are performing their courtships and scattering over cornfields and meadows. Thirdly, during the latter sunny days of Fall, when the mature individuals of the second brood are seeking their winter quarters, and many of them already making love preparatory thereto.

ITS MIGRATION ON FOOT.

Although the Chinch Bug is abundantly able to fly, yet as a rule it does not take to wing readily. Indeed, between the periods of flight mentioned above, these insects are, for the most part, unable to fly, for the simple reason that they are in the adolescent growing stages, and have not yet acquired wings; for no insect acquires wings until it has attained the imago or full grown state. Thus in migrating from a field of grain after it has been reduced and exhausted, or in passing from a wheatfield to a cornfield, after the wheat has been cut, these myriad sappers and miners are forced to march on foot, and they often do so in solid columns, inches deep. In such case the few more early matured individuals, which have wings, generally keep with the crowd and show no inclination to use their recently acquired power of flight.

HEAVY RAINS DESTRUCTIVE TO THE CHINCH BUG.

"As the Chinch Bug, unlike most other true bugs, deposits its eggs underground, and as the young larvæ live there for a considerable time, it must be manifest that heavy soaking rains will have a tendency to drown them out. The simple fact, long ago observed and recorded by practical men, such as Mr. B. E. Fleharty, of North Prairie, Knox county, Ill., that this insect scrupulously avoids wet land, proves that moisture is naturally injurious to its constitution. Hence it was many years ago remarked that very often when spring opens dry, chinch bugs will begin to increase and multiply in an alarming manner; but that the very first heavy shower checks them up immediately, and repeated heavy rains put an almost entire stop to their operations. It is very true that nearly all insects will bear immersion under water for many hours, and frequently for a whole day, without suffering death therefrom; for although animation is apparently suspended in such cases, they yet, as the phrase is, 'come to life again.' But no insect, except the few that are provided with gills like fishes and extract the air out of the water, instead of breathing it at first hand, can stand a prolonged immersion in water without drowning—and it must be obvious to the meanest capacity that an insect such as the Chinch Bug, whose natural home is the driest soil it can find, will have its health injuriously affected by a prolonged residence in a wet soil.

"In fact, the whole history of the Chinch Bug, from the very earliest records which we have of it, points unmistakably to the fact that a wet season affects it injuriously, and often almost annihilates it. In Carolina and Virginia, during the dry years which preceded 1840, it had become so numerous that the total destruction of the crops was threatened; but fortunately, unlike its predecessors, the Summer of 1840 was quite wet, and the ravages of the bug were at once arrested. In Illinois and in this State it had increased to an alarming extent during the latter part of the last rebellion; but the excessive wet Summer of 1865 swept them to such an extent that it was difficult to find any in the Fall of that year. So it was again in 1869–70, and so it always has been and doubtless will be."

It will be remembered that in some parts of the State we had several generous rains in July which were most grateful after the preceeding excessively dry weather. No one who was not in and about the cornfields can have any idea of the almost magic effect of those rains in destroying the chinch bugs. Of the vast swarms that a few weeks before, had blackened and deadened the rows of corn adjacent to harvested wheatfields, fully two-thirds in many localities were dead and rotting, whether above the ground between the blades, or below ground upon the roots; and these dead and drowned comprised bugs of all ages, and especially the larvæ and pupæ.

DIRECT REMEDIES AGAINST THE CHINCH BUG.

When a field of wheat or barley or rye, is once overrun by chinch bugs, man is, in the majority of cases, powerless before the unsavory host, and his only hope is in timely rains. The great majority of noxious insects may be controlled even at the last hour, but a few—and among them is the Chinch Bug—defy our efforts when once they are in full force upon us. There are several applications that will kill the insect when brought in contact with it, and I have known a few rows of corn to be saved by the copious use of simple hot water, but the application of all such direct remedies becomes impracticable on the scale in which they are needed in the grain fields of the West. Irrigation, where it can be be applied—and it can be in much of the territory in the vicinity of the Rocky Mountains, where the insect commits sad havoc; and with a little effort, in many regions in the heart of the Mississippi Valley—is the only really available, practicable remedy, after the bugs have commenced multiplying in the spring. *I wish to lay particular stress on this matter of irrigation*, believing as I do, that it is an effectual antidote against this pest, and that by overflowing a grain field for a couple of days, or by saturating the ground for as many more in the month of May, we may effectually prevent its subsequent injuries. In the article on the Rocky Mountain Locust, I may have something more to say on this matter of irrigation. We cannot, at the critical moment, expect much aid from its natural enemies, for these are few, and attack it mostly in the winter time. We must, therefore, in our warfare with this pest, depend mainly on preventive measures where irrigation is impossible.

PREVENTIVE MEASURES.

It has been repeatedly shown in these pages, that in no department of science does the old proverb, "prevention is better than cure," apply with such force as in economic entomology; for there are hosts of insects whose depredations may be averted with the utmost ease, when we understand their weak points and attack them at the proper place or time. Though we are powerless before the Chinch Bug at the time it commits the greatest injury, and attracts most attention, yet I shall endeavor to show that it may, for all practical purposes, be outflanked by judicious husbandry and proper precautionary steps.

Burning—It has long been noticed that the Chinch Bug commences its ravages in the Spring from the edges of a piece of grain, or occasionally from one or more small patches, scattered at random in the more central portions of it, and usually dryer than the rest of the field. From these particular parts it subsequently spreads by degrees over the whole field, multiplying as it goes, and finally taking the entire crop unless checked up by seasonable rains. In newly broken land, where the fences are new, and consequently no old stuff has had time to accumulate along them, the Chinch Bug is seldom heard of. These facts indicate that the mother insects must very generally pass the winter in the old dead stuff that usually gathers along fences. Hence, by way of precaution, it is advisable, whenever possible, to burn up such stuff in the winter, or early in the spring, and particularly to rake together and burn up the old corn stalks in the fall of the year, instead of plowing them in, or allowing them, as is often done, to lie littering about on some piece of waste ground. Agriculturally speaking, this may not be the best way of enriching the soil; but it is better to lose the manure contained in the corn stalks than to have one's crop destroyed by insects. Whenever such small infected patches in a grain field are noticed early in the season, the rest of the field may often be saved by carting dry straw on to them, and burning the straw on the spot, Chinch Bugs, green wheat and all; and this will be still easier to do when the bugs start along the edge of the field. If, as frequently happens, a piece of small grain is found about harvest time to be so badly shrunken up by the bug as not to be worth cutting, the owner of it ought always to set fire to it and burn it up along with its ill-savored inhabitants. Thus, not only will the insect be prevented from migrating on to the adjacent corn-fields, but its future multiplication will be considerably checked.

As was clearly shown by Dr. LeBaron, in his second report as State Entomologist of Illinois, much of the efficacy of burning corn stalks will depend on the manner in which it is performed and the time of year of its performance. The approach of Winter finds the bugs scattered everywhere over our corn-fields. But the fields themselves afford very little Winter shelter, and though standing corn stalks may harbor the bugs more or less throughout the Winter, the fact remains that the majority of the bugs leave them and seek greater shelter and more favorable quarters. Thus, to be effectual, the stalks should be cut and burned before Winter sets in; or what is preferable, shocks should be made at intervals to attract the bugs. The bugs will then congregate in these shocks and may there be burned at any time during the winter. In this connection I will quote the following inquiry from Mr. J. T. Moulton, Jr., of St. Francois county:

> The most compact and destructive army of chinch bugs I ever saw, started from sorghum bagasse, which had been used as manure. Might the insects be trapped to any extent worth mentioning, by exposing heaps of rubbish in conspicuous places in August, and burning the same in November? Would a great proportion of the eggs be found in such heaps?

The eggs would of course not be found in such heaps, as they are laid only on the living grain, and principally below the surface of the ground at the crown or on the roots of the plant. But they would nevertheless be effectually destroyed in the manner you suggest, because each female bug sheltering under the bagasse carries within her ovaries a number of undeveloped eggs which, as soon as Spring opens, she is ready to consign to the roots of young grain. The plan suggested by Mr. Moulton is therefore a capital one; and it matters little whether bagasse, corn-stalks, or any other rubbish be used, so long as the heaps are not too large and compact, and are placed and destroyed by fire at the times mentioned.

Where the custom of allowing cattle to range during the winter in the husked corn-fields, even the few chinch bugs which secrete in these stalks are apt to get killed by the feeding and tramping.

ROLLING—As the mother Chinch Bug has to work her way under ground in the spring of the year, in order to get at the roots upon which she proposes to lay her eggs, it becomes evident at once that the looser the soil is at this time of the year the greater the facilities which are offered for the operation. Hence the great advantage of plowing land for Spring grain in the preceding Autumn, or, if plowed in the Spring, rolling it repeatedly with a heavy roller after seeding. And hence the remark frequently made by farmers, that wheat harrowed in upon old corn ground, without any plowing at all, is far less infested by Chinch Bug than wheat put in upon land that has been plowed.

INVIGORATING THE PLANT BY MANURE: EARLY SOWING, ETC.—It has long been observed that Fall wheat suffers less than Spring wheat from this insect, for the simple reason that it generally matures before the bugs have attained their greatest power for harm. The Tappahannock wheat, on account of its early ripening, is, for this reason, one of the safest kinds to grow. There is also a strong impression among those who have had a good deal of experience with the insect, that it thrives best on sickly and weakly grain. While in such questions it is always somewhat difficult to distinguish between cause and effect, the following experience of that close observer, Mr. J. R. Muhleman, of Woodburn, Illinois, would certainly seem to show that the bugs do show some choice of food in a corn-field:

> I had a piece of very vigorous corn opposite my neighbor's wheat, and after it was harvested, that corn nearest the wheat became black with bugs. Now, the small field on which I raised my corn, is various in quality, ranging from rich to barren. My supply of manure did not hold out to cover all the latter, so that the corn thereon grew but slowly and remained weak. About a week after I had first noticed the bugs on that strong fast-growing corn, as mentioned above, I passed again by it, and found the bugs had abandoned it. That corn, and that which grew on the manured portions of the field remained free from the bugs during the remainder of the season, and I began to think the bugs had left entirely; that corn turned out well—as well as it promised in the forepart of the season.
>
> At the time of cutting the corn I became undeceived, for I found all the *weak* corn full of the stinkers, suggesting to me that they had thus abandoned the big heavy stalks, because, as I suppose, the sap flowed too fast for their comfort, and they went at the more etiolated, slowly growing corn. Upon frequent inquiry in different parts of the county, I have found that corn growing in bottoms was comparatively free from the bugs and made good corn, while upland corn, and especially such grown on rather thin land, was destroyed by them.
>
> The lesson I would therefore draw from these observations is, that early planting, manuring, and close attention in cultivation, especially on uplands of poor soil, will reward the tiller with a reasonable yield, as far as the Chinch Bug is concerned.

There can be no doubt as to the soundness of the lesson my friend draws in the last paragraph, and much of the freedom from chinches that has been noticed to follow the steeping of the seed in brine, or the use of salt and lime on the soil, may be traced to the vigor which the applications gave to the plants.

MIXING SEED OR PROTECTING ONE PLANT BY ANOTHER.—A strip of Spring wheat might be sown around a field of Fall wheat, as suggested by Mr. Carr (see Appendix), so that when the bugs have sucked it dry, or as soon as the Fall wheat is cut, and before they have started for other fields, the Spring wheat with its contents may be burned. Other preventive measures of this character have been tried, such as the sowing of a rod or two of Hungarian grass or millet around a wheat field, with a view of satisfying the bugs till the desired crop is out of danger. I have also known some to practice planting a few rows of sorghum, which is tougher than the corn. The bugs remain on the sorghum till ready to scatter by wing, when there is little danger to the corn, because it is then too strong and vigorous to be much affected by the young of the second brood.

Preventing the Migration of the Bugs from one Field to Another.—When, after having exhausted a field of grain, they are marching to another; or when, after wheat is cut, they are making in close columns for the nearest corn, they may be checked in their progress in the following manner, which I give in the words of Mr. H. J. Everett, of Stoughton, Wisconsin, who first recommended it:

> Take common fence boards, six inches or less wide, and run them around the piece, set edgewise, and so that the bugs cannot get under them or between the joints, and then spread either pine or coal tar on the upper edge, and they will not cross it. The tar needs renewing until the edge gets saturated, so that it will keep wet and not dry in any more, and either kind of tar is effectual. Then dig holes close to the board, about like a post hole, once in four or five rods, and run a strip of tar from the top of the board to the bottom on the outside, opposite the hole, and they will leave the board, and in trying to get around the tarred stripe, will slide into the hole, where they will be obliged to remain till they can be buried at leisure, and new holes opened for more victims. It is seldom one has to fence more than one side of the field, but wherever the fence is it is a sure stop.

With a little care to keep the tar moist by renewal, the boards may be dispensed with, and the tar poured out of the kettle onto the ground. About a gallon is required to a rod, and it should be renewed every other day, or oftener when rains prevail, until the bugs are destroyed in the manner before indicated. According to Dr. LeBaron, this plan was extensively resorted to in 1871, around Bloomington, Illinois, where the coal tar could be easily obtained, and it gave most satisfactory results. The same end may be attained by plowing a deep furrow or two at a short distance one from the other around a field it is intended to protect; and from the ease and cheapness with which this plan is executed, it is likely to become the most popular. The earth should be thrown away from the protected field, and the furrow not allowed to settle or harden, but be kept friable or dusty by dragging a log or a stone or a bundle of brush along it each morning. The philosophy of the plan is that the bugs cannot climb up the loose surface, especially on the perpendicular side. The dragging each morning will kill many, but they should be either trapped and destroyed in pits as already described, or burned by strewing straw each morning on the invading side of the furrow, and burning the same each evening, when a chinch bug holocaust will result.

IMPORTANCE OF WINTER WORK AND COMBINED ACTION.

Measures such as these last are, however, but partially preventive; we destroy the enemy only after he has just committed his principal ravages. Those, therefore, which strike at the right place and prevent the bug from doing any injury, are by far the most important and valuable; and I cannot lay too much stress on the importance of Winter work in burning cornstalks, old boards and all kinds of grass, weeds, rubbish and litter around grain fields, and even the leaves in the adjacent woods, in and under all of which the little pest hibernates. Next to drowning out the rascals, cremation is undoubtedly the most effectual mode of destruction. Next, let Spring wheat be got in as early as possible, and let it be rolled. The rolling will apply equally well to the culture of Winter wheat, though I would not advise the early Fall planting of this last in sections where it is likely to suffer from Hessian fly, for reasons not pertinent in this connection. Sow thickly, as the more the ground is shaded the less the Chinch Bug likes it. If in late Winter the bugs are known to be numerous so as to bode future injury—and the fact can easily be ascertained by the ill-savored odor they send up from corn-shocks and by their general presence in the wintering places mentioned—it will be well to plant no Spring wheat or barley. In short, just in proportion as we adopt an intelligent and cleanly system of culture, just in that proportion will the Chinch Bug become harmless: it is, in a great part, and in its more injurious aspects, a result of slovenly husbandry, and will lose its threatening character in the more western States, as it has in those to the east of us, just as fast as more careful and intelligent husbandry becomes the fashion. Combined effort is, also, most important in this connection, and it is by producing unity of action in such cases that the granges can demonstrate, in no small degree, the good that is to flow from organization. While the farmers were uncombined they were as weak as a rope of sand in matters requiring this combined effort, but with the powerful organization now existing among them, they will be better able to cope with their foes of whatever nature.

Every one who has traveled over our own State, must have been struck with the manner in which some fields were rendered almost worthless by this insect; while others in the immediate vicinity, and sometimes not more than a quarter of a mile away, were entirely exempt from its injuries. I have had no difficulty in accounting for these circumstances in the light of what is here stated.

Much good winter work may be done also in the way of trapping the bugs. In seeking winter quarters, they show a decided partiality for any flat substances, such as old boards, that do not rest too closely upon the ground. If all old boards that can be obtained are laid around a field, in the Fall, in such manner that the larger part of the lower surface will not quite rest on the ground--which of course it will not do if the ground is in the least bit uneven or covered with grass—the bugs will congregate under such traps, and during the cold weather of Winter may be scraped from them on to dry straw and burned.

In this connection, and to show the folly of waiting till the last moment, I take the liberty of publishing the following letter as a sample of many that reach me about harvest time:

Dear Sir: I once noticed in the Kansas agricultural reports an article from your pen on noxious insects, and how to destroy them, and a few days since I read in the St. Louis *Globe* of the good work you were doing. I now write to you in the hope that you can do as good a turn for a sad lot of farmers as you did for Mr. Whittaker.

We are being eaten out by the Chinch Bug; Spring wheat and barley utterly ruined—none left to eat; Winter wheat damaged one-half, and whole fields of corn being laid waste. I hear of many instances where from ten to fifteen acres are gone, and the bugs marching steadily on. A few persons are trying to stop them by spreading straw in their way and burning or dragging logs; some are trying coal tar; but generally the bugs are marching onward.

I look from my window on a fine, large field of oats over half ruined. Many are cutting oats in the bloom or milk to save something.

I have seen grasshoppers twice, and would prefer them of the two. If you can tell us something about them and how to prevent their ravages, drive off or destroy them, you will confer upon us the greatest favor and receive our heartfelt thanks.

Wishing you God-speed in your noble efforts to help our insect-cursed country,

I am, with respect,

H. V. NEEDHAM,

Master of Grange No. 71, P. of H.

Summit, Kansas.

All such letters, when they come from citizens of Missouri, I make it a point to answer, as far as other duties will permit; but from the rather lengthy account of the Chinch Bug here given, it is obvious that relief in all cases like that of Mr. Needham, is sought at the last moment, when it cannot be got except through providential rains or irrigation. Yet it is always at this last moment that the cry of distress goes up from the large body of farmers, or that any efforts are made to avert it, except by the few who have been properly informed and understand the habits of the enemy. That these last form but a small (though I am happy to say constantly increasing) portion of the agricultural community is, perhaps, to be regretted. A practicable, everywhere available, cheap remedy, that would give relief at this critical period, is from the nature of the case, hardly to be hoped for. Yet it is not an impossibility; and if I could devote to the effort my whole time for one single year, with the means to test on a large scale, thoroughly and effectually, the many different methods that suggest themselves to my mind—as the use of sulphate of copper or of iron; of carbonic acid gas or of sulphuret of carbon—something might come out of the list of possible remedies, and thousands of dollars might be cheaply expended in the attempt where such large interests are involved. Regarding the use of carbonic acid gas, it is probable that it would destroy the bugs on a hill of corn, if thrown on to them at a distance of not more than two feet; but from experiments which I made upon chinches with a Babcock extinguisher, I am of the opinion that little can be expected from its use as thrown from this machine. The gas escapes too rapidly to be of any great practical service, and has no effect on the bugs when thrown in a jet five feet long.

Abstaining from the Cultivation of the Grains upon which the Insect feeds.—On the principle that it is better to save the labor and seed than to lose both and the harvest withal, the idea of quitting the culture of the cereals, and especially of Spring wheat and barley, for a year or two, as a means of preventing the breeding of the insect to any injurious extent, has often been considered and discussed. There is some reason to believe that the abandonment, for a single year, of barley and Spring wheat culture, over a sufficiently large extent of country—as, for instance, over a whole county—would cause a sufficient reduction in the numbers of chinch bugs in such a county, as to insure fair crops for two or three succeeding years; and such a course is well worth trying. It is to be feared, however, that it will never be carried out in concert over a sufficiently extended breadth of country; 1st, because the farmer can never foretell the character of the coming season, on which the increase or decrease of the pest so largely depends, and will naturally hope for the best; 2d, because if neither Spring nor Fall wheat, barley, oats, rye, Hungarian grass, timothy nor corn were grown for one season in any given county where there are wild prairie grasses, the Chinch Bug would yet breed, though not so numerously.

NATURAL ENEMIES.

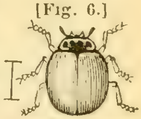
Practically we have not much to hope for from the natural enemies of this bug; for they are neither numerous nor efficient enough to make any material impression on the vast army of chinches which invade our grain fields; neither are they of such a nature as to be greatly encouraged, or artificially multiplied for man's good, as in wholesale measures of destruction it is impossible to separate the sheep from the goats. Yet it will afford some satisfaction to the farmer to be able to recognize even these few friends which assist, in their quiet way, to keep his inveterate foe in check.

"As long ago as 1861, Mr. Walsh, in his *Essay upon the Injurious Insects of Illinois*, published facts which tended to show that four distinct species of Ladybirds preyed upon the Chinch Bug.* The first of these four is the Spotted Ladybird (*Hippodamia maculata*, DeGeer, Fig. 5), which also preys upon a great variety of other insects, attacking both the eggs of the Colorado Potato-beetle and those of certain Bark lice.

[Fig. 5.]

SPOTTED LADYBIRD.

[Fig. 6.]



TRIM LADYBIRD.

"In corroboration of the fact of its preying on the Chinch Bug, I may state, that the Rev. Chas. Peabody, of Sulphur Springs, informs me that he has repeatedly found it so feeding on his farm. The second species is the Trim Ladybird (*Coccinella munda* Say, Fig. 6), which is distinguishable at once from a great variety of its brethren by having no black spots upon its red wing-cases. The other two are much smaller insects, belonging to a genus (*Scymnus*) of Ladybirds, most of the species of which are quite small and of obscure brown colors, and hard to be distinguished by the popular eye from other beetles, the structure of which is very different, and which therefore belong to very different groups and have very different habits.

"In the Autumn of 1864, Dr. Shimer ascertained that the Spotted Ladybird which has been sketched above, preys extensively upon the Chinch Bug. In a particular field of corn, which had been sown thick for fodder, and which was swarming with chinch bugs, he found, as he says, that this Ladybird, 'could be counted by hundreds upon every square yard of ground after shaking the corn; but the chinch bugs were so numerous that these hosts of enemies made very little perceptible impression among them.'

"In the same Autumn Dr. Shimer made the additional discovery, that in the very same field of fodder-corn the chinch bugs were preyed upon by a very common species of Lacewing-fly, which he described in January, 1865,† as the Illinois Lacewing (*Chrysopa Illi-*

* See *Trans. Ill. St. Agric. Society*, IV, pp. 346-9.

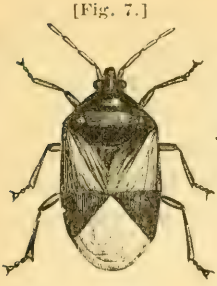
† Proc. Ent. Soc. Phil., IV, pp. 208-12.

noiensis). The description was republished, together with the substance of Mr. Shimer's observations in the *Prairie Farmer*, of Chicago, Ill., accompanied with a non-characteristic wood-cut of the larva, cocoon and imago. At this time Mr. Shimer favored me with two specimens of the perfect insect, and he likewise furnished Mr. Walsh with additional specimens. From these specimens, it is evident that the species is the same as that described long before, by Dr. Fitch, as the Weeping Lacewing (*Chrysopa plorabunda*). In 1863, I found the same species quite numerous in a wheat-field belonging to Mr. T. R. Allen, of Allenton, where its larvæ were perhaps feeding on the chinch bugs, as they were found to do in North Illinois, by Dr. Shimer. The Lacewing-flies all bear a striking resemblance to one another, both in size, shape and color. They almost all of them, in fly state, have a characteristic and disagreeable odor, resembling nothing so much as human ordure. (For further details see Rep. 1, pp. 57–8, and Rep. 6, Fig. 10).

"According to Dr. Shimer, the Weeping Lacewing-fly was not quite as abundant as the Spotted Ladybird among the fodder-corn, but still there were so many of them, that he thought that 'there was one or more of them for every stalk of that thickly sown corn.' 'Every stroke of the cutter,' he adds, 'would raise three or four dozen of them, presenting quite an interesting spectacle as they staggered along in their awkward, unsteady flight.' And he not only actually observed the larvæ preying very voraciously on the chinch bugs in the field, but he reared great numbers of them to the mature fly by feeding them upon chinch bugs. His account of the operations of the larva when in captivity is so interesting that I quote it in full:

I placed one of the larvæ in a vial, after having captured it in the field in the very act of devouring chinch bugs of all sizes, and subsequently introduced into the vial a number of chinch bugs. They had hardly reached the bottom before it seized one of the largest ones, pierced it with its long jaws, held it almost motionless for about a minute while it was sucking the juices from the body of its victim, and then threw down the lifeless shell. In this way, I saw it destroy in quick succession, about a dozen bugs. Towards the last, as its appetite was becoming satiated, it spent five or more minutes in sucking the juices from the body of one bug. After this bountiful repast, it remained motionless for an hour or more, as if asleep. Never for a single moment, during the feast, did it pause in the work. When not in possession of a bug, it was on the search for, or in the pursuit of others. It manifested much eagerness in the pursuit of its prey, yet not with a lion-like boldness; for on several occasions I observed a manifest timorousness, a halting in the attack, as if conscious of danger in its hunting expeditions, although here there was none. Sometimes, when two or more bugs were approaching rapidly, it would shrink back from the attack, and turning aside go in the pursuit of others. At length, awakening, it would renew the assault as before. On one occasion, when it was on the side of the vial, two inches up, with a large bug in its mouth, I jarred the vial, so that it fell to the bottom and rolled over and over across the bottom, but holding on to its prey, it regained its footing and mounted up to its former position. Occasionally the chinch bugs would hasten to escape when pursued, as if in some degree conscious of danger.

[Fig. 7.]

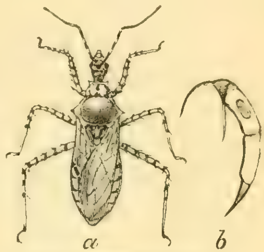


INSIDIOUS FLOWER-BUG.

The Insidious Flower-bug (*Anthocoris insidiosus*, Say, Fig. 7.) which is so often found preying on the leaf-inhabiting form of the Grape Phylloxera, and which is not unfrequently mistaken for the Chinch Bug, is quite commonly found in connection with this last, and in all probabitity preys upon it.

The Many-banded Robber (*Harpactor cinctus*, Fabr. Fig. 8.), also preys upon the Chinch Bug. It is quite frequently met with and I have detected it in the act.

[Fig. 8.]



MANY-BANDED ROBBER.

"The common Quail of the Middle and Western States (*Ortyx Virginiana*) otherwise known as the Partridge in the Northern States, has long since been known as a most efficient destroyer of chinch bugs, and the fact was some time ago published by myself in the *Prairie Farmer*, and by others in various agricultural journals and Reports. We also have the corroborative testimony of Dr. Shimer, who is a good ornithologist. In the Winter time, when hard pushed for food, this bird must devour immense numbers of the little pests which winter in just such situations as are frequented by the Quail; and this bird should be protected from the gun of the sportsman in every State where the Chinch Bug is known to run riot." It is gratifying to know that this fact has become sufficiently recognized to have gained for the bird legislative protection in Kansas. Prairie chickens are also reported as devouring it, but I do not know that any absolute proof has been given. Mr. J. W. Clarke, of Green Lake county, Wis., also reports seeing the Red-winged Blackbird feeding on it.* Finally, Mr. B. W. Webster, of Austin, Cass county, and G. C. Brackett, Secretary of the Kansas State Horticultural Society, have both written me to the effect that ants destroy its eggs.

POSSIBLE REMEDIAL AND PREVENTIVE MEASURES THAT NEED FURTHER AND THOROUGH TRIAL.

There are a number of *possible* remedies or preventive measures that suggest themselves to any one having a thorough acquaintance with the insects' economy, the thorough trial and test of which will require much time, labor and expense. There are others which are from year to year continually recommended on pretty good authority.

*Prairie Farmer, April 9, 1870.

None of them can be recommended with any assurance; yet it will be well to enumerate a few of the more plausible, as worthy of more thorough trial, in the hope that some of our Western Agricultural Colleges, having the opportunities and facilities, will be induced to carry out such a system of carefully conducted experiments, as will forever settle the question of their utility—a system which it is impossible for the State Entomologist of Missouri to carry out, with present means and duties.

In June, 1871, Mr. Wm. F. Talbott, of Richmond, Ills., strongly recommended in the columns of the *Missouri Republican* the use of salt and brine—the salt to be sown with the seed at the rate of about a half barrel to the acre and the brine to be poured on the plants. The recommendation was extensively copied, but subsequent trial has proved that the bugs are not particularly affected by it. Yet as a fertilizer and by invigorating the plant and hastening its maturity so that it will ripen before the insect acquires the greatest power for harm, such an application may prove highly beneficial; and this fact will account no doubt for some of the favorable reports of the use of salt. The same may be said of lime and gas lime which have been extolled by some and denounced by others as chinch bug antidotes.

There is a very general impression that hemp is obnoxious to the Chinch Bug, and no end of instances are reported where grain crops surrounded or interspersed with it have been unmolested, while other adjacent fields have been injured. The testimony is, however, somewhat conflicting. Flax, too, is recommended as having the same power of protecting from chinch bug ravages; and Mr. S. T. Kelsey, of Hutchinson, Kans., who is abundantly able to judge intelligently, and has had good opportunity so to judge, reports that last year, in Kansas, small grain planted on ground where flax was grown the previous year, generally escaped damage from the bugs. He recommends sowing with wheat and other grains, one or two quarts of flax seed per acre. "It can be put in early in the spring, even with fall wheat by a light harrowing and rolling, (if a roller can be had) so as to not damage the grain. Its growth could not materially injure the crop, and if the seed ripened it could be easily separated. Some people sow flax and barley mixed on the same ground, separate the seed in cleaning, and claim that it pays better than sowing either one alone. If flax is really offensive to the Chinch Bug, so that they will not stay around it, why may we not "flax" the pests out of our grain fields entirely?"*

* *Kansas Farmer*, January 13, 1875.

Mr. Alfred Gray, the enterprising Secretary of the Kansas State Board of Agriculture, who has made a number of official inquiries, gets substantially the same favorable reports as to the influence of flax.

A similar influence is claimed for castor beans and even for buckwheat; and some years back Mr. Erwin, Agricultural editor of the Fulton (Mo.,) *Mail*, informed me that, having once gotten a poor stand of corn, he harrowed it and sowed to buckwheat. The Chinch Bug almost destroyed the rest of his corn, but did not work on this piece. The tendency of buckwheat to keep the ground moist may throw some light on this experince.

It has been recommended to sow with each 12 bushels of winter wheat, one bushel of Winter rye; and with Spring wheat the same proportion of Winter wheat—with the idea, I suppose, that the bug prefers the young to the old plants. There is little harm in the methods and they are worthy of further trial.

There are a great many other proposed remedies that appear in the columns of our agricultural journals each year—some of them utterly absurd and founded on ignorance; others of doubtful utility, because founded on isolated experience, where too often it is evident that cause and effect have not been properly understood. It is needless to instance them. As to the ridiculous proposal put forth in the Waukegan, Ills., *Gazette* in 1865, with a great blowing of trumpets, by one D. H. Sherman, of that town, namely, to destroy the Chinch Bug in the egg state by pickling all the seed wheat, it is sufficient to observe that this insect never deposits its eggs upon the kernel of the ripe wheat. Consequently, to attempt to kill chinch bug eggs by doctoring the seed wheat, would be pretty much like trying to kill the nits in a boy's head by applying a piece of sticking plaster to his great toe. In the old *Practical Entomologist*, nine years ago, I showed that there were no such eggs in the wheat kernels, which Mr Sherman himself had sent me, and which he had supposed to be thus infested. Of course the same remark applies to every other proposition to destroy this insects' eggs by manipulating the seed—however beneficial such measures may be as a means of invigorating the plants, causing an early start, or preventing rust and smut.

INJURIOUS TO STOCK.

Accounts reached me from several sources, and were common in the agricultural papers, of stock being injured when fed with corn fodder badly infested with the bug; and I have no reason to doubt that animals confined to corn-fodder in seasons when every corn-stalk harbors dozens or even hundreds of bugs, will suffer from eating them—the symptoms described being a falling off in flesh and constipation. *Verbum sat sapienti.*

PROGNOSTICATING.

After such a Chinch Bug season as we had in 1874, the question is continually asked during the Winter: "Will there be any chinch bugs next Summer?" It is impossible to give any satisfactory answer to such a question, because so much depends on the character of the approaching Spring. We had some very severe and continued cold weather this Winter, and many entertain the hope that the chinches have been frozen out. The farmer must lay no such unction to the soul, however; for it is not intense cold but changeable Winter weather—successive thawings and freezings—that injures and destroys the Chinch Bug.*

UNNECESSARY FEARS.

While some thus take a bright view often unwarranted by the actual facts, others again are unnecessarily pissimistic and hopeless of the future prospects—borrowing trouble where there is, perhaps, no cause for it. This fact may be illustrated by the following letter from Mr. Wm. H. Avery, of Lamar, Barton county, as a sample:

> About a month or six weeks ago, numerous farmers of this county reported finding large quantities of dead chinch bugs on the ground beneath shocks of corn. They were so numerous that double handfuls could be taken up without much effort, and many believed that all the bugs in the country were dead. One man said that he had observed that what appeared to be dead bugs were only the shells or outer covering of bugs, and he believed the bug itself had only escaped from its old covering.
>
> I have not heard of any living chinch bugs being seen for two or three months, though I have not made particular search.
>
> P. S. Since writing the foregoing, Dr. Dunn and I have made search in the fields for living chinch bugs and could find none, while dead ones are abundant.
>
> I send you, in another wrapper, a piece of corn-stalk containing the bugs just as we found them.

Now in the corn-stalk sent, though, on a superficial view, it appeared black with chinches, there was not a single living bug to be found. What had been mistaken for them was a mass of the empty pupa-skins. We have seen, in speaking of the insect's transformations, how, at each successive molt, the colors of the perfect bug are more and more approached, until in the pupa state, both in color and size, there is great resemblance to the mature bug. When about to undergo the last molt, i. e., to shed the pupa-skin, the insects in late

* Since this was written, I have found the Chinch Bug by millions in its Winter quarters, and on the 28th and 29th of March—the weather being quite warm—they already began to move and fly about. This shows that the long and severe Winter had little effect on them.

Summer and Fall, are fond of congregating on corn-stalks in the shelter afforded by the broad blades; and since all insects, in molting, fasten themselves as securely as possible, and as none of them that live by suction, like the Chinch Bug, ever devour their cast-off garments, as many of the mandibulate species are known to do, the cast-off pupa-skins in such corn-stalks remain indefinitely between the blades. Again, many chinch bugs naturally die in the Fall or in the Winter, either from disease or from having run their course; while in some years, as Dr. Shimer has conclusively shown, and as I can testify from personal examination, a very general fatality attends the hibernating bugs, so that it is difficult to find a living one. In all such cases, a little careful research by aid of an ordinary lens will soon enable the farmer to determine whether he is dealing with dead or living chinches, or only their skeletons. The pupa-skins, though distended, with every leg-covering perfect, readily reveal their mocking emptiness under the lens or by the pressure of the finger, and while, when numerous, they speak in unmistaken terms of the large numbers of chinches that came to maturity in the Fall, they bear no evidence of the present strength, nor furnish any clue to the future power of the foe: the dead bugs are generally covered with mold and are discolored and soft: the living ones are bright-colored, and will soon begin to kick and crawl on being brought into a warm room.

BOGUS CHINCH BUGS.

"Few things are more astonishing than the acuteness of perception superinduced by being constantly conversant with some one particular subject. I have often been surprised at the readiness with which nurserymen will distinguish between different varieties of Apple, even in the dead of the year, when there are no leaves, and of course no fruit on their nursery trees. In the same way old practiced shepherds can recognize every individual sheep out of a large flock, though, to the eyes of a common observer, all the sheep look alike. Experienced grain-growers, again, can distinguish at a glance between twenty different varieties of wheat, which the best botanist in the country would fail to tell one from the other; and I have been informed that a miller of many years' standing, as soon as he has shouldered a sack of wheat, knows at once whether it is Spring grain or Fall grain; while ninety-nine entomologists out of every hundred would probably be unable, on the most careful inspection, to tell the difference between the two, and some might even mistake wheat for rye.

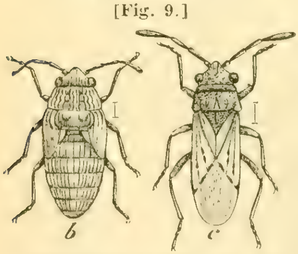
"It is not surprising, therefore, that persons who have paid no particular attention to the study of insects, often confound together insects which, in the eyes of the professed entomologist, look as different from each other as a horse does from a cow or a hog. It would, indeed, be little short of miraculous if this were not so; for there are about thirty thousand distinct species of insects to be found within the limits of the United States, and of course in such a vast multiplicity, there must be many strong resemblances.

"I will therefore conclude this article on the Chinch Bug, by briefly mentioning several true Bugs, belonging to the same sub-order of Half-wing Bugs (*Heteroptera*), as that pestilent little foe of the farmer, and which I know to be frequently mistaken for it. The reader will then, by comparing the different figures, see at once how widely they all differ, and by a very little practice, his eyes will become so well educated that he will soon, without any artificial assistance from glasses, be able to distinguish the creatures one from the other, as they crawl or fly about in the almost microscopic dimensions assigned to them by their Great Creator.

"One reason, perhaps, why so many different bugs are popularly confounded with the Chich Bug, is the similarity of their smell. Everybody is aware that chinch bugs possess the same peculiarly unsavory odor as the common Bed Bug; and hence when a person finds a small insect that has this obnoxious smell, he is very apt to jump to the conclusion that it must be a chinch bug. No mode of reasoning, however, can be more unsafe or unsound. There are hundreds of different species of Half-wing Bugs—the common brown Squash Bug (*Coreus tristis*) for example—that possess this peculiar smell."

THE FALSE CHINCH BUG.—This insect is most often mistaken for the genuine article, and letters like the following, received from a correspondent last Fall, are not uncommon, and relate to it:

[Fig. 9.]



FALSE CHINCH BUG:—*b*, pupa; *c*, mature bug.

I came across a (to me) curious thing the other day. I have allowed the purslane to grow in my strawberry ground this Summer, thinking to protect the plants from the sun somewhat. Lately we have been clearing it out, and I was much surprised to find under the rank growth millions of chinch bugs. They were not all in the perfect state (winged), but many not half grown. Can they be the real thing? They look like it, and certainly *smell* like it. But the wing-marks do not seem as distinct or broad, only five white lines crossing at an acute angle. Also, the young ones are not red, but ashen gray, and with bodies thicker and broader than the true grain bug. What were they there for? They would not feed on purslane, would they? and no other weeds were there. I found quantities of leaves and fragments of leaves on the ground; but the Chinch Bug is not an eater, but a sucker, I suppose. If they were there to Winter, it would be advisable to rake it all off and destroy it in some way, but purslane dies hard as well as Chinch Bug. Coal oil, though, will kill him as quick as lightning.

As there is an account, with description, of this False Chinch Bug in my 5th Report, it is only necessary to say in this connection that the species is a very general feeder and in the Spring of the year does much damage to many plants, such as young grape-vines, strawberries, potatoes, young apple grafts, but especially to plants of the Cabbage family. It is especially fond of purslane, and at approach of Winter, congregates beneath it in immense numbers. Long after Jack Frost has blackened and deadened all but the very butts of the plants, these bugs may be found under them, running actively about whenever the sun is the least warm. They are found at this time of all ages, but principally mature and in pairs, and it is doubtful if any but the mature ones survive the Winter.

All the reports—and such come sometimes from noteworthy sources—of chinch bugs injuring herbaceous plants, vegetables and vines, owe their origin to the confounding of this, the bogus, with the true Chinch Bug; for though the latter may occasionally be found sheltering under purslane and other plants, it does not feed on any other than those already indicated.

THE INSIDIOUS FLOWER-BUG—Next to the preceding species, this little fellow, already referred to (p. 41, *ante*) as preying on the Chinch Bug, is quite often mistaken for it, having somewhat similar colors, and being so often associated with it.

THE ASH-GRAY LEAF-BUG—This species (*Piesma cinerea* Say, Fig. 10), is also often mistaken for the great American grain pest. It is a small greenish-gray bug, its size being about the same as that of the Chinch Bug, though it is flatter, broader, with shorter legs, and lacks altogether the conspicuous black and white markings which characterize that little grain pest, and really resembles it in nothing but the unpleasant odor which it emits. It has been found doing some damage to grape blossoms in early Spring, but is not otherwise very injurious, as it lives principally on forest shrubs and trees. The Ash-gray Leaf-bug belongs to an entirely different group (*Tingis* family) from the Chinch Bug, all the species of which have a short 3 jointed beak, which however differs from that of the 3-jointed beak of the Flower-bugs (*Anthocoris*) by being encased in a groove when not in use. They mostly live on green leaves in all their three stages,

[Fig. 10.]

ASH-GRAY LEAF-BUG.

after the fashion of plant-lice. Like the Chinch Bug, the Ash-gray Leaf-bug hibernates in the perfect state, and may be found in the Winter in considerable numbers under the loose bark of standing trees and especially under that of the Shag-bark Hickory. It also frequently swarms in the air, and I have gathered it by hundreds on top of one of the highest buildings in St. Louis, on a warm October day.

THE FLEA-LIKE NEGRO-BUG—Fourth among the bogus chinch bugs may be mentioned the Flea-like Negro-bug (*Corimelæna pulicaria*, Germar, Fig. 11). Its color is black with a white stripe each side. This insect resembles the Chinch Bug in having an ordinary 4-jointed beak, but differs from it in belonging to a very distinct and well marked group (*Scutellera* family), which is characterized by the enormous size of the "scutel" or shield. This bug has a great passion for the fruit of the Raspberry, and is sometimes so plentiful as to render the berries perfectly unsaleable by the bed-bug aroma which it communicates to them, as well as by sucking out their juices. Wherever it occurs, the nauseous flavor which it imparts to every berry which it touches, will soon make its presence manifest, though the little scamp may elude ocular detection. It is really too bad that such a little black "varmint" should so mar the exceeding pleasure which a lover of this delicious fruit always experiences when in the midst of a raspberry plantation in the fruit season. It is also quite injurious to the Strawberry, puncturing the stem with its little beak, and thus causing either blossom or fruit to wilt. It also attacks both Cherry and Quince, occurring on these trees in very large numbers, and puncturing the blossoms and leaves, but especially the fruit stems, which in consequence shrivel and die. It is also quite injurious to garden flowers and especially to the Coreopsis, and abounds on certain weeds, among which may be mentioned the Red-root or New Jersey Tea-plant (*Ceanothus Americanus*), and Neckweed or Purslane-Speedwell (*Veronica peregrina*). In the month of June under these two last named plants, they may be found in countless numbers of all sizes and ages, from the small light brown wingless, newly hatched individuals, to the full fledged jet black ones. Though found on so many different plants however, it does not, like the true Chinch Bug injure, or in any way effect, our grasses and grains.

[Fig. 11.]

FLEA-LIKE NEGRO-BUG.

"To these four bogus Chinch Bugs, might be added one or two other species of small stinking bugs which have been, by some persons, mistaken for the true Chinch Bug. But enough has been already said to show, that insects which in reality are shaped and fashioned as differently as are cows and deer, are yet often confounded together in the popular eye, principally, no doubt, because they have the same peculiar bed-bug aroma. Should the ignorance of the popular judgment in confounding these tiny creatures, which seem to the Entomologist so very, very different from each other, therefore, be despised and ridiculed? Far be it from me to display such intolerant stupidity! As well might the nurseryman ridicule the grain-grower because the grain-grower cannot distinguish a Baldwin Seedling from a High-top Sweeting; or the grain-grower the nurseryman, because the nurseryman cannot tell Mediterranean from Tea wheat, or Club from Fife. I do, however, entertain an abiding hope that by the present very general and praiseworthy movement toward the popularization of natural history, and by the dissemination of Entomological Reports, a better knowledge of this practically important subject will soon exist in the community. Our farmers will then, not so often wage a war of extermination against their best friends, the cannibal and parasitic insects, while they overlook and neglect the very plant-feeders which are doing all the damage, and upon which the others are feeding in the very manner in which a Wise Providence has appointed them to adopt."

RECAPITULATION.

While there is much more on this interesting subject to be said, the length this article has already assumed prompts me to bring it to a close; and I will recapitulate by giving a condensed statement of the more important facts relating to the Chinch Bug:

The Chinch Bug injures by suction, not by biting.—It winters in the perfect winged state, mostly dormant, principally in the old rubbish, such as dead leaves, corn-shucks, corn-stalks, and under weeds and prostrate fence rails and boards that generally surround grain fields; also, in whatever other sheltered situation it can get in adjacent woods: hence the importance of fighting the pest in the Winter time, either by trapping it under boards laid for the purpose, or by burning it with its afore-mentioned shelter. Such burning will not destroy all the dormant hosts, but will practically render the species harmless—especially where whole communities combine to practice it.—It issues from its Winter quarters during the first balmy days of Spring, when those females which were impregnated the previous Fall, and which are most apt to survive the Winter, commence ovipositing at once, if suitable conditions are at hand. Others take readily to wing and scatter over our fields, attracted by preference to grain growing in loose and dry soil, into which they penetrate to consign their eggs.—The eggs are deposited on the roots, and the young bugs, which are red, remain under ground, sucking the roots during the early part of their lives, or until they are forced from necessity to travel from one plant to another. These Spring-hatched bugs, constituting the first brood, do not, as a rule, acquire wings till after wheat is cut. It is, therefore, during and just after wheat harvest, that they congregate and travel in such immense swarms as to attract attention.—In July, as these acquire wings, they scatter over grass, late grain and corn-fields, where they lay their eggs; but the second brood, hatching from these eggs, generally attracts less attention and does less injury than did the first, because of its more scattered nature and the greater maturity and resisting power of the plants.—Anything that will prevent the mother bug from getting at the roots of the grain, will prevent the injury of her progeny: hence the importance in this connection of Fall plowing and using the roller upon land that is loose and friable; and hence, if old corn ground is sufficiently clean, it is a good plan to harrow in a crop of small grain upon it without plowing at all. The earlier, also, that wheat gets well started and matures, the less it will suffer; because it may be harvested before the bugs acquire their greatest growth and power for harm: hence, and from the greater compactness of the ground, Winter wheat suffers less than Spring wheat.—Heavy rains are destructive to the Chinch Bug: hence, if such occur in the Fall, the farmer may plant with little fear of injury the following year, while if they occur in May, he need suffer no anxiety, so far as chinch bugs are concerned: hence, also, where irrigation is practicable, the pest may at all times be overcome.—It injures no other plants than grasses and cereals.—In its migrations from field to field it may be checked by a line of tar poured on the ground, or by deep furrows or trenches, but the tar must be kept soft and the surface of the furrows friable and pulverized.

APPENDIX

TO THE

ARTICLE ON THE CHINCH BUG.

To publish entire all the answers to the questions in the circular sent out over the State would be an unnecessary waste of space; and I have, in this Appendix, endeavored to condense as much as possible without omitting any statistical facts or experience in any way valuable. In order to save space and avoid repetition, I give the returns by counties, signed by the initials of the correspondents, and preface by a list of the gentlemen who have favored me with replies and to whom I hereby tender my sincere acknowledgments. From the counties following which there are no names, reports have failed to come to hand; while a number of replies are unrecorded, because they came to hand without the postoffice address or the county being indicated. In some counties, as St. Louis, I have been able to make personal observations.

LIST OF CORRESPONDENTS WHO MADE RETURNS.

ADAIR—E. M. C. Morebeck, * *; John S. Erwin, Kirksville. ANDREW—J. H. Smith, Whiteville; Jacob Kimbertin, Rochester; R. H. Talbot, Bolckow; John White, Flag Spring. ATCHISON—B Bond, * *. AUDRAIN— — — BARRY—S. M. White, Washburn; W. F. Tuttle, Hazle Barrens. BARTON—A. A. Dye, M. D., Lamar; J. J. Bryning, Doylesport; W. H. Avery, Lamar. BATES—W. R. Thomas, Lone Oak; G. B. Hickman, Mulberry; Addie Haynes, Rockville. BENTON—J. A. Hughes, * *; James H. Lay, Warsaw; W. F. Joplin, Lincoln; J. H. Maxwell, Mt. View; J. M. Murress, Windsor. BOLLINGER— — — BOONE—J. B. Douglass, Columbia. BUCHANAN—M. W. Farris, Agency; J. P. Reichard, St. Joseph. BUTLER—Albert Ponder, Freddie; John M. Allen, Cane Creek. CALDWELL—C. L. Gould, Hamilton; D. W. Monroe, Kidder. CALLAWAY— — — CAMDEN— — — CAPE GIRARDEAU—Henry Bruihl, Appleton; H. G. Wilson, Cape Girardeau; R. H. Burford, Burfordsville. CARROLL—H. S. Hall, Van Horn. CARTER— — — CASS—W. H. Barron, Raymore; H. L. Hewitt, Austin; P. C. Homey, * *; D. Defabaugh, Harrisonville; W. A. Smith, East Lynn; J. L. Kanaga, Raymore. CEDAR—E. W. Montgomery, Cane Hill; C. N. Jordan, Whitehare; W. Smiley, Stockton. CHARITON—R. Fox, Westville. CHRISTIAN—R. P. Lawing, Ozark. CLARK—B. P. Haman, Clark City; D. H. Lapsley, Kahoka. CLAY—G. T. Odor, * *; Dan. Carpenter, Barry; J. C. Evans, Harlem. CLINTON—A. J. McCrayner, Plattsburg. COLE—Frank M. Dixon, Jefferson City. COOPER—W. R. Baker, Lone Elm. CRAWFORD—James Asher, Clinton Mills; M. O. Taylor, Bourbon. DADE—Ross A. Workman, Greenfield. DALLAS—G. A. Howerton, * *; M. L. Reynolds, Buffalo. DAVIESS - Israel Coen Jamesport; G. D. McDonald, * *; W. W. Woodbridge, Jamesport; L Dowell, Bancroft. DEKALB—Horatio Morris, Winslow; G. E. Shulz, Havana; W T. Wallingford, DeKalb. DENT— — — DOUGLAS—W. Pryon, Pryon's Store. DUNKLIN—W. G. Bragg, Kennett. FRANKLIN—F. W. Pehle, New Haven; S. Miller, * *. GASCONADE—Henry Read, * *. GENTRY—A. J. Clark, Gentryville; Levi

Long, Mt. Pleasant; Charles S. Whitescarver, Mt. Pleasant; Hugh Stevenson, Gentryville; W. H. Rogers, Alanthus; H. W. Johnson, New Castle; J. A. Mauring, Havana; Elisha Brace, Sampson Creek; James Shillingham, * *. GREENE—S. A. Edmonsom, Walnut Grove. GRUNDY—Val. Briegel, Trenton; G. H. Hubbel, * *. HARRISON—J. Whiteley, New Castle; Col H. Fitch, Eagleville; J. H. Burrows, Cainsville; Sam. McCray, Mitchellsville; C. F. Fransham, Yankee Ridge; Wm. Rakestraw, Bethany. HENRY—D. C. McIntire, Norris Fork; J. E. Stringer, Leesville; T. J. Quick, Gaines. HICKORY—W. L. Snidow, Elkton; James W. Dickerson, * *; C. J. Hostetler, Wheatland. HOLT—Bennet King, * *; J. W. Crow, Bigelow; W. Kaucher, Oregon; J D. White, Forest City; J. W. Maple, Oregon. HOWARD—Garnett W. Morehead, Glasgow. HOWELL— — — IRON—W. Cam. Belleview. JACKSON—Dr. John L. Gregg, Stony Point; W. S. Parrish, Hickman's Mill; J. W. Geiger, Hickman's Mill; J. A. Moore, Pink Hill; W. J. Gault, New Santa Fee. JASPER—J. M. Peterson, Preston; W. G. L. Craig, Smithfield; J U. Thornburg, Reeds; Thomas McWallie, Avilla. JOHNSON—W. Campbell, Holden; J. L. Cleland, Chalybeate; Dr. Dunkly, Dunksburg; D. B. Reavis, Kingsville; E. J. Coleman, * *; J. Milo Martin, Pittsville; J. L. Motsinger, Fayetteville. KNOX—Jac. Wiegerter, Millport. LACLEDE—L. R. Rupart, Hazle Green. LAFAYETTE—James Belt, M. D., Napoleon; J. J. Ferguson, Sniabar; James E. Gladish, Aullsville. LAWRENCE—W. L. Goodman, Mt. Vernon. LEWIS—W. B. Dement, Bunker Hill. LINCOLN— — — LINN—A. Moyer, Brookfield. LIVINGSTON— — — MACON—W. B. Martin, College Mound. MADISON—Joseph M. Anthony, Fredericktown. MARIES—D. L. Dodds, Vienna. MARION—J. K. Martin, Philadelphia; W. R. Anderson, Palmyra; Rufus M. Brown, Palmyra; S F. Taft, Hannibal. McDONALD—W. D. Palson, Southwest City. MERCER—J. H. Burrows, Cainsville. MILLER— — — MISSISSIPPI—S. S. Smith, Bertrand. MONITEAU— — — MONROE—J P. Myers, * *. MONTGOMERY—D. T. Mitchell, Jonesburg; E R. Brown, Montgomery. MORGAN— — — NEW MADRID—James S. Barney, New Madrid. NEWTON—John Thrasher, Neosho; W. H. Wetherell, Seneca. NODAWAY—W. B. M. Harman, Pickering; W. Pittman, Marysville; W H. Clark, Luteston; T D. Wallace, Hopkins. OREGON—J. R. Woodside, Thomasville. OSAGE—Lucien Philbert, Dauphine. OZARK—James Price, * *; T. J. Gideon, * *. PEMISCOT— — — PERRY—R. M. Brewer, Perryville. PETTIS—Elihu Canaday, Ionia; L H. Williams, M. D., Houstonia; O A Crandall, Sedalia; C. R. Hoag, Sedalia. PLATTE—James Adkins, Platte City; R. P. C. Wilson, Platte City. POLK—T. W. Simpson, Payne's Prairie; M. D. Mitchell, Morrisville; John Carson, Bolivar; H. M Wallard, Humansville. PULASKI—Charles Curtis, Dundas; O. J. Ryther, Iron Summit. PUTNAM—A D. Thomas, Terre Haute. RALLS—A. E. Trabue, Hannibal. RANDOLPH—W Quayle, Moberly. RAY—* *, Morton. REYNOLDS— — — RIPLEY—B Hassell, Doniphan. ST. CHARLES—C. Weinrich, New Melle. ST. CLAIR—S. H. Long, Taborville; W. H. Fillery, Collins; C. A. Schooley, Taborville. ST. FRANCOIS—E. H. Perkins, Farmington; F E Clay, * *; A. J. Leathers, Farmington. STE GENEVIEVE—J R. Prichard, Bloomsdale. ST. LOUIS— — — SALINE—Jno. P McManus, Lutesville. SCHUYLER— — — SCOTLAND—Albert North, Memphis. SCOTT—H. P. Lynch, M. D., Commerce. SHANNON— — — SHELBY—John B. Randal, High Prairie Home. STODDARD— — — STONE— — — SULLIVAN—Sumner Boynton, Milan. TANEY—J. J. Brown, Forsyth; W. R Howard, Forsyth. TEXAS—R. S. Smiley, Houston; George A. Bezoni, Roubedoux. VERNON—M. L Modrel, Little Osage; J A. Princeton, Schell City. WARREN—D. P. Dyer, Warrenton. WASHINGTON—W. Riehl, Potosi. WAYNE— — — WEBSTER— — — WRIGHT—E. B. Griffin, Hartville. WORTH— — —

QUESTIONS ANSWERED BY CORRESPONDENTS.

1. How far back in the history of your county has this insect been known to injure the grain and grass crops?

2. What crops have suffered most from its ravages?

3. Have any systematic efforts ever been made to overcome its injuries? and have you any idea to what extent my Second Report—which contained all that was known about the insect up to that time, and which was bound in with the Fifth (1869) State Agricultural Report—is distributed or known of among the farmers of your county?

4. Give approximately this year's estimated damage in your county, by this single insect—all crops affected by it considered.

The answers, here following, are numbered to correspond with the questions. Those to questions 1 and 2, which have been summed up on pages 22, 23, 26 and 27, and which are very similar, are almost entirely omitted.

Adair County.

3—No systematic efforts have been made to overcome them. I know nothing of your Second Report; have never seen one.—E. M. C. M. The only attempt to check them has been by plowing a furrow and dragging a log in it. They have sometimes been prevented from passing from grain into corn by this means. I believe very few here have seen the report to which you refer.—J. S. E.

4—I cannot arrive at anything like a correct report for this year. In some locations whole fields of corn, especially late planting, oats and Spring wheat. The last named grain we hold to be the nursery of the Chinch Bug.—E. M. C. M. I believe that 20,000 dollars is a moderate estimate of the damage to crops in this county for the present year.—J. S. E.

Andrew County.

3—None have been made.—J. H. S. No preventives found against them.—J. K. None. Your reports do not get into the hands of many farmers.—R. H. T. None. I have no knowledge of your report on that insect.—J. W.

4—The corn crop has been damaged this year at least one-half.—J. H. S. I should estimate that the damage done this year by these bugs would amount to fully ($40,000) forty thousand dollars.—R. H. T. About 33 per cent.—T. W.

Atchison County.

2—The crop of this year principally injured by Chinch Bug is the corn crop, as they made their appearance too late for small grain.—B. B.

3—No systematic effort has been made to overcome its injuries; but very few copies of your Second Report were distributed among the farmers of this county.—B. B.

4—The damage to the corn crop is fully one-third to one-half, and they are still, to this date (December 24), alive in all protected places.—B. B.

Barry County.

1—The Chinch Bug has never been known in the county or in this section of country prior to the Summer of 1874.—S. M. W. It never was known in this county until this Summer.—W. F. T.

3—No systematic effort has ever been made to overcome its ravages and injuries. I do not know, neither can I learn, of your Second Report being distributed among the farmers.—S. M. W. Nothing has been done to overcome its injuries. I know nothing about your Second Report, but would like to see it.—W. F. T.

4—The wheat was not hurt to any great extent, as it was ready to harvest before they made their appearance in any very great quantities. Corn—late corn—in some localities was ruined. Hereabouts corn was not seriously injured as it was large and forward at the time of wheat harvest. Probably 10 per cent. would cover the whole amount of damage done to all crops. * * * —S. M. W. The damage done in this county was fully one-half of the crops of corn and sorghum, and the entire crop of Hungarian grass and millet, which would amount to many thousands of dollars.—W. F. T.

Barton County.

3—Yes. Some have sown Hungarian grass between wheat and corn, for it seems to be in the wheat-fields that the first crop is hatched. Some neighborhoods have not sown any wheat at all. After the first crop has hatched in the wheat, they plow around the field or keep continually running a roller around it so as to crush them. This seems to keep them back for a week or two. When they get large enough to fly, they leave the wheat-fields and scatter in all directions, where they lay their eggs and hatch out the second crop. * * * —A. A. D. No. Said Report has been seen and known comparatively little.—J. J. B. No efforts have been made to overcome its injuries. I do not think your Second Report is at all known or distributed among the people of this county. To-day, I inquired at every place in town where I might expect to find it, but could not. Nor could those most likely to know tell me anything of it.—W. H. A.

4—On account of our extreme drouth here the last season the Chinch Bug did more than its usual amount of damage—probably $100,000 worth.—A. A. D. Any estimate of said damage would be hard to make, approximating the truth, without a vast deal of trouble, as our wheat was affected some, but chiefly because of the drouth, and oats almost a failure from the same cause. True, both suffered some from the bug, and as to the corn crop in our county, perhaps not one-sixth of an average crop was harvested; one-half of which might be owing to the prevalence of the bug—that is to say, without either bug or drouth, and *with* either alone three times as much could have been raised. Our wheat crop was better than an average since '68.—J. J. B. Cannot estimate the damage from this source this year, as it is impossible to say how much is attributable to the drouth and how much to the bug. Some farmers think they would have had much better corn if it had not been for the bug, but as they raised almost *none*, it is a doubtful question.—W. H. A.

Bates County.

1—The corn crop has suffered most the past season from their ravages. * * * The first crop was not two-thirds grown at the time of wheat harvest. They commenced to fly July 20th and settled all through the corn-fields, but the greatest injury was done by the second crop in the latter part of August and first of September. We think the third crop of them was hatched the first of October, but are inclined to think not many of them came to maturity as we find them dead on the corn-stalks now not more than half grown. * * *—W. R. T.

2—This year for the first time farmers showed some fight. * * *—W. R. T. No efforts have been made to overcome its injuries that have availed any thing; plowing them under and dragging logs, etc., is all that has so far been done. Your reports, on inquiry for them, I find have never been distributed at all among the farmers, and, in fact, I cannot find a copy in the county.—G. B. H. The heat was so intense for several days during the middle of August, that by pulverizing the ground to fine dust and then shaking them from the corn into it, they would roast in half a minute. We are convinced that not more than half a dozen farmers in this county ever received a copy of the Agricultural Report for 1869; in all probability it was more freely distributed among lawyers, merchants and doctors, than farmers. We applied for a copy but never received one.—A. H.

4—There was more wheat sowed this year than ever before in my circle of acquaintance, and while some raised a little wheat many never raised a bushel; if the county raised the seed it is all it has done. Oats were nearly destroyed. * * * The corn crop will not average more than five or six bushels per acre, and as I am not posted with regard to the number of acres in cultivation in Bates county, I am unable to make anything of a correct estimate, but the damage would be fearful.—W. R. T. The damage by this insect in our county this year is impossible to state as we have almost a total failure, and the whole of it is due to Chinch Bug; nothing escaped it in the shape of grain or grass. * * *—G. B. H. We estimate the damage done by this insect alone in this county at not far from one million dollars.—A. H.

Benton County.

3—No efforts made. Your Second Report is not known here.—J. A. H. No systematic efforts have been made against them. A little desultory plowing of furrows is all that has been done. I have never heard of a copy of your Second Report in the county. I desire a copy.—J. H. L. There are no systematic efforts being made to overcome its injuries. I do not think your Second Report is very generally known or distributed among the farmers of Benton county.—W. F. J. No systematic efforts have been made. Don't know anything about your Second Report.—J. H. M.

4—The corn crop was probably damaged 45 per cent. by the bugs and 45 per cent. by the drouth, leaving us about 10 per cent. of a good crop. Our wheat being mostly in the timber was not badly damaged. Inferior wheat crops on the prairie were completely destroyed. Good ones escaped with little damage. * * *—J. H. L. It would be an impossibility to give any correct estimate of damage by its ravages, as the Chinch Bug and dry weather together have caused almost an entire failure in this county.—W F J. The damage done by this single insect in our county the past season is so great that I cannot give an estimate.—J. H. M.

Boone County.

4--I cannot approximate the estimated damage in my county.--J. B. D.

Buchanan County.

3—None that I know of. I have no idea that more than one-tenth of the people in this county ever heard of the Report.—M. W. F.

4—The estimated damage would reach several thousand dollars. Have no way of making a correct estimate with me at the present time.—M. W. F..

Butler County.

3—There has been no effort made for their destruction. I have no idea how far your Report has been distributed.—A. P. None.—J. M. A. One-half the crops are destroyed this year.—J. M. A.

Caldwell County.

2—Corn was injured worst, wheat next, oats least; Spring wheat ruined. I believe that the chinches killed new seeding of grass, especially when sowed on wheat or oats ground.—C. L. G.

3—None. Have never seen it, and cannot tell to what extent it has been distributed.—D. W. M. There are in this county 432 sections of land. I estimate one-eighth of the land in the county was planted in wheat and corn, which at $2.00 damage per acre, would give about $70,000. Add to this amount nearly as much more damage, caused by farmers being obliged to sell their hogs and cattle without fattening, (and I am satisfied this is the actual fact): I therefore estimate the whole damage done by chinch bugs in Caldwell county at $125,000. I remember that one year in Wisconsin they were so numerous that in their migration they fell into Lake Michigan, and washed ashore in such quantities as to make a stench along the beach. If this shall be of any use to you in your good work, I shall be amply rewarded.—C. L. G.

Cape Girardeau County.

3—No remedies have been tried that seem to be effective.—R. H. B. No, I think not. Some farmers are talking about burning off the stubble-fields and burning the woods lands, but they do not agree very well about it. I had a field of heavy wheat stubble burned by accident the past Summer, in which there were a few bugs. I shall notice the result next year. I have practiced Fall plowing since I have been farming, and I rather think that it keeps the bugs in check. I have in mind one field that was in corn three years ago, when the bugs first appeared; it had been plowed the Fall before. My neighbors' fields were troubled with bugs that year but this field was not. It was again plowed in the Fall and put in oats in March following, and if there were any bugs in the oats I did not discover them. The oats were taken off in July, the ground immediately plowed and sowed to Hungarian grass. The grass was taken off the 1st of September, the ground immediately plowed, and first of October replowed and sowed to wheat. A good crop of wheat wast taken off last June, the ground plowed in July and again first of September and sowed to grass for meadow. It is now green all over the field, and if that field has ever had any chinch bugs in it I have failed to find them. On the opposite side of a lane lies another field having about the same fertility (rich bottom) and separated by a public road and fences. The latter field was sowed to barley in September, 1873—harvested in June last year. The crop was light—only 25 bushels per acre, when it should have produced 40. I did not know even at harvest, that the chinch bugs were the cause of the short crop. This barley stubble was plowed as quick as the grain could be taken off, and on the first of July the ground was nicely planted with sprouted corn. The corn came up quickly—the ground being rich it grew fast and had a dark green color—but when about eight or ten inches high, I noticed that the bugs were thick on it. It seemed to withstand the effects of the bugs until four feet high, when it was then attacked by a kind of cut-worm of a green color, and the chinch bugs and the worms together completely ruined it. I would like to know more about this worm. [Probably the Fall Army-worm; see 3d Rep] I hope you will excuse this digression. I have stated facts—they may be of some use.—T. O. Your Second Report has not been distributed in this section of the county.—R. H B. No efforts that I am aware of, systematic or otherwise, have been made to overcome its ravages, except that it has perhaps induced somewhat earlier planting. Your Second Report alluded to, has not been distributed or known among the farmers of this county, except perhaps a few that may have been distributed by the members of the Legislature.—W. C. R. All crops considered, I should think it would be from $30,000 to $40,000.—H. G. W.

Carroll County

3—No systematic efforts have been made to destroy it. Your Second Report referred to, is not very generally distributed among the farmers, and very little is known of it. Like many other similar documents, it helps to fill up the lank libraries of landless lawyers and impecunious country editors. A State Senator has promised me a set of State Agricultural Reports for the library of Van Horn Grange, (now numbering 125 volumes) but I presume the promise will be forgotten.—H. S. H.

4—I have no data from which to estimate the money damage, but the wheat was badly shrunken, and three-fourths of the corn crop entirely destroyed this year by the chinch bugs. Dry, hot weather is favorable to its development. In wet seasons it does very little damage, * * *.—H. S. H.

Cass County.

3—[All the correspondents agree in stating that no systematic efforts have been made; and that little or nothing is known of my Second Report.]

4—Five hundred thousand dollars would be a low estimate of the amount of damage done by this pest in Cass county this year.—W. H. B. It is impossible to even approximate an estimate of damages. They injured Spring wheat and barley to such an extent that there has been no attempt for several years to raise either. Winter wheat was not injured as much in 1874 as in some previous years. Oats crop reduced at least 40 per cent. Corn (the principal crop cultivated) was injured to such an extent by drouth and bugs that the south half of the county will not average over ten bushels per acre, and that of *very* poor quality—principally chargeable to the bugs, from the fact that occasional fields more favorably situated, (by being partly or altogether surrounded by timber, at greater distances from fields of small grain, etc.,) made a fair average yield regardless of drouth. * * * —H. L. H. Can't make an estimate of the amount of damage done in the county this season. It was immense. They reduced the wheat and corn crop from one-fourth of an average yield to an *entire* failure.—P. C. H. The damage sustained by them in Cass county this year was fully 50 per cent.—D D. The amount of damage in this county is enormous. Corn nearly ruined, wheat and oats badly damaged.—W. A. S.

Cedar County.

3—[All the correspondents state that plowing and ditching and dragging were alone resorted to; and that nothing is known of my Second Report.] I can't say just how much we were damaged by the Chinch Bug; they ate about two-thirds of our crops clean. The farmers in this county are going to have a hard time to get through the winter.—E. W. M. They destroyed about one-third of the wheat crop, three-fifths of the corn crop, one-half the oats and Hungarian, and one-half the sorghum.—W. S.

Chariton County.

3—There never has been any effort made to destroy it, but I think it is high time that we make an effort in that direction. I do not think there is a farmer in my neighborhood that ever saw your Second Report or ever knew anything about it.—R. F.

4—It is impossible for me to give anything like a correct estimate of the damages done by this insect during the past season, because we had a protracted drouth which commenced with the bugs and lasted through the entire growing season. Spring wheat was totally destroyed, and none but the early Fall wheat escaped its ravages, and I think there is scarcely a stalk of corn in all the western, northern and northeastern portions of this county that has not suffered more or less from this pest; and owing to the drouth and Chinch Bug combined, there was not five bushels of corn raised to the acre, taking the county over.—R. F.

Christian County.

4—The bugs cut off our corn on an average about six to seven bushels to the acre. —R. P. L.

Clark County.

3—No systematic efforts to prevent their ravages. I think your reports are not much known in Clark county.—B. P. H. No efforts have been made to overcome their injuries. You have my thanks for your Sixth Annual Report. I have failed to get hold of your former reports.—D. H. L.

4—Probably $20,000 or more. Many crops of Spring wheat and barley were entirely destroyed, and corn near such fields was badly injured by the bugs after leaving the small grain. They seemed also to breed in the corn in August and September, and caused a great deal of corn to shrivel while in roasting ear.—B. P. H.

Clay County.

3—No; neither systematic or spasmodic. I do not think your Report of 1869 is in the hands of one farmer in fifty, and I doubt if one in a hundred has ever seen it.—D. C. We do not think your Second Report was known of in our county, except in our immediate neighborhood, where it was distributed by our Missouri Valley Horticultural Society—J. C. E.

4—Corn was cut off one-third, oats nearly as much; wheat was damaged but little, it was too early for them.—G. T. O. Cannot give even a guess at the damage. I know some oat-fields yielding nothing, some wheat not over one-half crop, corn-fields the same, and thus graduating up to no injury at all—D. C.

Clinton County.

3—None. However, a few farmers burned their wheat-fields instead of trying to harvest them.—A. J. M'C.

Cole County.

3—No systematic effort has been made, as far as I can say, to checkmate the ravages of this pest. To what extent your Second Report has been distributed, I would say, to the best of my belief, not very extensively; nor do I believe such reports ever will reach the class of men they are intended for unless other ways are devised to distribute them more widely and with more certainty.—F. M. D.

Cooper County.

3—No systematic efforts have been made. * * * Your Second Report I do not think is distributed to any extent among the farmers of this county. I think the wheat and corn crop injured to at least one-fourth their value.—W. R. B.

Crawford County.

3—There has been no effort, only to sow early; this has saved the wheat crop this year. I have not seen one of your reports in the county.—J. A. There has been no systematic effort made to overcome its injuries to my knowledge.—M. O. T.

4—Wheat, none; oats, one-half; corn and grass the same.—J. A. I have endeavored by conversation with farmers and others in different parts of the county to obtain something near the amount of damage done by the Chinch Bug this year, but am unable to arrive at anything definite; suffice it to say it is thousands of dollars. * * * —M. O. T.

Dade County.

3—No. Individual efforts, such as plowing out a trench and dragging a log in it, or burning trash in it. Keeping a strip of fallow land between infested crops and those not infested, also planting objectionable crops, such as castor beans, between wheat and corn, has been tried, but with no very encouraging success. Your Second Annual Report is unknown to the farmers of this neighborhood. I have sought for it in vain.—As to my own experience, I find that enough chinch bugs do not winter over on my place (two miles from timber) to seed it in the Spring. But every Spring, soon after the earliest corn is up, they come in on the wing before the wind, and take possession of, and lay their eggs on, every green thing that suits their purpose. At the same time that the eggs hatched out in the wheat, they also hatched out in the early planted corn, while there were none in the corn and Hungarian planted and sown after the Spring invasion, until they were driven out of the wheat and oats by the harvesters. In these Spring migrations they always come from the same direction—southwest before a southwest wind, and apparently from a strip of timber on Horse creek, about three miles away. According to this, trenching, etc., will do very well for late crops, but is of no use for those crops that are up before the Spring migration, which occurred last Spring, as nearly as I can recollect, the first week in May, and all over the county at the same time. I believe that if we can get a good game law, absolutely prohibiting the trapping and netting of quails and prairie chickens, and then make the farmers see that it is to their interest to have it enforced, we will be injured no more by the Chinch Bug.—R. A. W.

Dallas County.

3—One of the most successful means employed is the following: As soon as you cut a piece of wheat or oats you will find they begin to migrate the same day to the adjoining crop, then you have your base of operation. Either haul straw, litter or something that will afford them shade, and about 2 or 3 o'clock P. M. you can, by burning the straw, burn millions of them. * * *—M. L. R.

4—Enormously; past my calculation. Have never seen a copy of your Second Report. Such documents are generally sent to lawyers, politicians, officers and professional men, who never read, much less make practical use of the valuable knowledge contained in them. I have often seen piles of such valuable books lay in our postoffice for months addressed to such persons. * * *—G. A. H. I am sure I will not make an overestimate of damage by the bug in placing it at $50,000.—M. L. R.

Daviess County.

3—During the last Summer, 1874, as soon as the wheat straw became dry the chinch bugs marched out of the wheat and into the corn; they went and blackened every stalk of corn for fifteen rows deep and next to the wheat. When I discovered this I took a large kettle and placed it near the Chinch Bug operations, filled it with water and went to work on them like some of our good house wives wage war on another insect that carries the same kind of odor. I thus cooked them by the millions. This ended their work of destruction in the field; the scalding did not destroy the corn, as it continued growing and produced good sound ears of corn.—J. C. None. I do not think there are ten farmers in the county that have ever seen your Report of 1869, or any other year. I have never had one in my possession until the last one you sent me. Through the kindness of our then Circuit Clerk, I had the privilege of reading your Report for 1869 in his office. I never had one to read and study as I would like to have done and to refer to when I needed information from it. I was once in the clerk's office where I saw a number of volumes of the Report. I asked the deputy Clerk if they were intended for distribution? He replied that the names of the persons whom they were intended for were written on them by our Representative. I looked over them and found but one farmer's name, and he a former Representative and more politician than farmer. * * * —G. D. M'D. There have been no systematic efforts made to overcome its injuries. Right here comes a difficulty: the majority of farmers are more disposed to growl at their enemies than to grapple with them; it being much easier to wait than to work. I often wonder that such men as yourself and others, who are doing so much to enlighten and benefit the farmers, do not become discouraged and disheartened. Permit me to remark, however, that the better class of farmers do appreciate their efforts. The State Agricultural Report for 1869, or any other year, has not been distributed in this county; if there are any copies of such reports in the county they must be in the hands of some judge or lawyer. I should be very glad to know how to obtain such reports.—W. W. W. No systematic efforts have ever been tried to overcome its injuries, and your Second Report is but little known or distributed here. A few copies of your Annual Report distributed in this county would do much good.—L. D.

4—Owing to the drouth and the chinch bugs we have not one-tenth part of an average crop of corn. It was the only crop seriously injured by them, though I heard of some fields of wheat and oats entirely destroyed by them.—G. D. M'D. Spring wheat and sorghum totally destroyed; corn, from one-third to one-half; oats, one-quarter; Winter wheat, one-sixth.—W. W. W. The exact amount of damage done by this insect can not be determined, but it will probably exceed $400,000 this year.—L. D.

DeKalb County.

3—Your reports are not known in this county.—H. M. None. Your Report spoken of has not been distributed in this section among reading and thinking men. I have heard of a few copies in the hands of a few political favorites of that day.—G. E. S. No efforts have been made to counteract their ravages, and your Second Report is not in the hands of but few, very few, of the farmers of this county.—W. T. W.

4—Destroyed three-fourths of our corn crop.—H. M. Damage to all crops about 35 per cent. this year.—G. E. S The damage has *not been nearly* so great in the timbered lands as compared with prairie lands.—W. T. W.

Douglas County.

3—No efforts have been made. I have no idea to what extent your Second Report was distributed among the farmers.—W. P.

4—I estimate the damage from this pest, all crops considered, at 35 per cent.—W. P.

Franklin County.

3—None.—T. W. P. I am not aware that any systematic efforts have been made to overcome its injuries, except in sowing such varieties of wheat as ripen early. It has been found that early maturing wheat is almost or entirely free from its ravages. I do not think that your Second Report has been distributed among the farmers of this locality.—S. M.

4—Chinch bugs have damaged this county from 80 to 100,000 dollars for the year 1874.—F. W. P. I believe 10 per cent. would be inside the damage done to all crops in this county by the Chinch Bug this season.—S. M.

Gasconade County.

3—No systematic efforts have been made for their destruction. Your Report is almost unknown in our midst; I managed to get one copy.

4—The estimated loss on corn and wheat occasioned by these bugs during the year 1874 will probably reach $55,000 or $60,000. The loss on sugar cane is not known, say $3,000 or more, as they are particularly fond of it; sometimes destroy the whole crops.—H. R.

Gentry County.

3—There has been no settled plan among the farmers to check the ravages of the bug. Your Second Report has never been circulated in this county.—A. J. C. None. Nothing known of your Second Report.—L. L. No effort made to overcome its injuries. Don't know of a copy of the Agricultural Report for 1869 in the hands of a farmer.—H. S. No systematic efforts have been made. Have never heard of your Report.—W. H. R. No. —. It is not in this part of the county.—H. W. J. No systematic efforts were made. Your report is little known.—J. A. M. No. Never saw it.—E. B.

4—I could not pretend to approximate the losses. They were terrible.—A. J. C. The damage this year has been very great; at the least value fully one-half of the corn and nearly all the Spring wheat and a great portion of the Fall wheat was ruined.—L. L. They have destroyed at least nine-tenths of the Spring wheat, one-sixth of the Fall wheat and one-sixth of the corn; oats, one-tenth.—W. H. R. This year's crops were injured 30 per cent.—J. A. M. Cannot do it, but will inform you that all Spring wheat was destroyed, and also one-quarter of corn.—E. B. The past Summer they destroyed nearly all the Spring wheat, many fields having never been cut, while many fields that were cut did not pay for the cutting. Hungarian grass suffered in about the same ratio as Spring wheat. Corn was badly damaged in places, slightly in others.—J. S.

Greene County.

3—None, except to plow ditches between the wheat and corn and drag a log in them. Don't know of a farmer that has one of your Reports.—S. A. E.

4—Corn five-tenths lost; wheat but little damaged; oats and hay one-half lost.—S. A. E.

Grundy County.

3—No systematic efforts have been made, and your Report is but little known. It is the general practice here to put out large corn crops, cherish great expectations, and see them devoured by these hungry pests. Spring barley is doomed to certain destruction, and no inconsiderable amount of wheat is thus annually lost. I have, indeed, sometimes heard farmers advocate clearing fence corners and burning corn-stalks to give them nothing to Winter under, but always concluding that as long as the rest don't fall in it is perfectly useless to trouble themselves about it.—V. B. No. Your Report is little known; say 10 copies in county.—G. H. H.

4—The average damage sustained by the corn crop was at least 60 per cent.; of the wheat crop about 25 per cent.—V. B. $50,000 is a moderate estimate. The corn crop was nearly ruined by them.—G. H. H.

Harrison County.

3—No. Not distributed among farmers generally.—C. H. F. No. Very little, I think.—J. H. B. None have been made. Your Report is not known in this neighborhood.—S. M'C. To my knowledge, none have been made. My idea is that if any of your Reports of 1869 were sent to this county, they were distributed amongst the merchants and mechanics, and not among those that would be benefited by getting them. —C. F. F. None have been made, and your Report is not much known among farmers. —W. R.

4—The damage this year to all crops has been 25 per cent.—J. W. Not so bad this year as in some other years.—J. H. B. They commenced later last Summer than usually, and worked later in the Fall. They did not damage Winter wheat very much, but cut the corn crop fully one-half short.—S. McC. Spring wheat, in many places, entirely destroyed; cane damaged one-fourth, and corn, from chinch bugs and dry weather, not half a crop. Many claim that the bugs did more damage than the dry weather.—C. F. F. They took half the corn crop, all the Spring wheat, half the young meadows damaged.—W. R.

Henry County.

3—[All three of the correspondents unite in the statement that no systematic efforts have been made, and that they have seen nothing of my Second Report.]

4—The damage done by Chinch Bug and drouth cannot fall short of one million of dollars.—D. C. M'T. It would be a difficult matter to give an estimate of the damage caused by them here this year, as no one escaped entirely and large fields of grain were destroyed.—J. E. T. They and the dry, hot weather ruined our corn almost entirely, and oats also, so that we have not seed of either, and the most of us think of quitting small grain. * * * If we have another dry season like last year we are ruined, for there are plenty of people here now that have next to nothing to live on or to keep their stock with.—J. J. Q.

Hickory County.

2—Corn crops suffered most from its ravages, although old bugs that lived through last Winter, and there were legions of them that did, commenced their work in destroying the young growing wheat in early Spring, and some fields of wheat were totally destroyed by them before the wheat got in bloom, and by the time the corn was in silk and tassel, it was covered alive with the little devils; and fields of corn that were near or adjoining to wheat-fields, were killed dead by the time it was half leg high. The weather being very hot and dry, they would destroy acres a day. I am of the opinion that there were at least three if not four broods of the devils in the year, the last brood came out in the latter part of September, and it does look to me as if the little fellows had nearly all died off with cold, thirst and hunger, the sap being so completely dried up in the vegetation when they came out they could find nothing to feed on; in the fields one could see them by the millions crawling on the ground hunting something to feed on; one can see millions or legions of dead ones in the dry corn-stalks. I made a close search for live ones the other day; I only found two alive. I am satisfied with the same pains last Winter one could have found thousands of them alive. I give it as my opinion that if they died off everywhere else in Missouri as they have here, they will do but little damage next season.—W. L. S.

3—No effort has been made yet. Last Fall many farmers did not sow any wheat on account of the bugs. About your Second Annual Report, there may be some in the county, but I do not know of a single copy.—C. J. H.

[The other answers are to the same effect.]

4—The damage this year is more than I am able to estimate correctly; it is thousands of dollars.—W. L. S. The damage this year is great, but I cannot give a correct estimate.—J. W. D. To give an estimate of the damage done by chinch bugs would be impossible for me to do. I think about one-fourth the wheat crop was destroyed, and over four-fifths of the corn crop, and one-third of oats and young timothy. * * * My idea is, if we would plant no corn, or all early corn that would ripen before the second crop of bugs would be hatched, there would be no bugs to Winter, and that would run them out. C. J. H.

Holt County.

3—None. Your former reports have not circulated much beyond the officers of our agricultural society. B. K.—No. I have the first man to find yet that ever heard of the Report you speak of. J. W. C.—Where they exist in stubble, it is found that Fall plowing exterminates many of them. This recently has also been found to be effectual in destroying grasshoppers, that is, where they are turned under pretty deep before being hatched. Your Reports are extensively read by farmers in Northwest Missouri. The only fault being that they are not generally distributed; but few copies ever find their way here only through our Representative, and they fall far short of the demand. Many of our newspapers, through downright ignorance of what they are writing about, speak lightly of the results of your department, as they do also of the agricultural department. I think that if your Reports, besides being published in book form, could be distributed in printed slips as fast as prepared, and published in the county papers, at least, a great amount of good might be effected. Nearly every farmer of any intelligence might be reached in that way. The State had better pay for the printing of such information in the newspapers than for the publication of the laws, as very few men read the latter, but depend solely for their interpretation upon the lawyers and others who read them. —W. K.

4—My estimate of their damage in this county for 1874, is as follows, to-wit.:

To 1,000,000 bushels corn, at 50 cents per bushel	$500,000
To 40,000 bushels small grain, at same	20,000
To 2,000 gardens, at $10 each	20,000
Total damages, actual	$540,000

This is a low estimate.—B. K. You cannot get two farmers to agree about what they were damaged. I believe my corn was damaged at least one-half, or thirty bushels to the acre; my wheat but little.—J. W. C.

Howard County.

3—None. Was not much distributed or known.—G. W. M.

4—The corn suffered more than wheat this year; $50,000 approximate damage—G. W. M.

Iron County.

3—No systematic efforts have been made to check them. Few, if any, copies of your Reports have been distributed here—W. C.

4—Damage may be divided as follows: Corn, $100,000 to $125,000, (¾ of the crop); wheat, $30,000 to $45,000; oats, timothy, Hungarian and sorghum, (last destroyed), $20,000 to $30 000. My own experience is that by sowing no Fall wheat, except what can be sown early and well, and rye same, we might in a few years rid ourselves of this pest. I have noticed that in a spot manured lightly with stable muck, Fall wheat *never* suffers. If the ground is strong enough to give a good, healthy straw, carrying plenty of silica or glazing up with it, they *cannot* damage it much, and if stubble and trash was more generally burned, they would not breed in it, or under it, rather. The young broods get out here in the latter half of June, and early wheat is ready for the sickle by the 15th or 20th. Spring wheat seems to encourage and increase them more than anything else. I have not had the time or means to experiment, but think the best way, after the way suggested above, to prevent them, or even better perhaps with it, would be to sow thickly a strip of Spring wheat around the Fall wheat, and then when they had sucked it dry, which they would as soon as the Fall wheat was out, and before they began to move for other fodder, set it on fire after nightfall, if practicable, to prevent their flying from the flames. A strip of sorghum sown or planted in rows would entice and delay them, but would not burn unless straw or other combustible material was strewn in it. P. S.—I was hauling stock fodder for my stock the other day, and observed a great many chinches that were dormant, but quickened when exposed a minute or two to the warm sun, and it occurred to me that after this, whenever I had a cornfield infested with Chinch Bug I would cut and shock it all up, so that when it was hauled out in the Winter, while the bug was dormant and helpless, they would be exposed, trodden in the manure and destroyed Certain it is that where they swarm as thickly as they have done here for three or four years, we should not adopt or practice one plan of destroying them, but every plan. It seems peculiarly unfortunate that at this juncture, when the productive industry of the whole country is reduced to such straits by having borne the onus of the hot-bed system of protection to manufacturing enterprises, that we should be compelled to contend at such a disadvantage with such an enemy as this, and yet, "looking through nature up to nature's God," I cannot but regard it as a blessing in disguise, for it will *compel* our slow, conservative clod-hoppers to adopt better and more careful methods of cultivation.—W. C.

Jackson County.

3—None that I have heard of. I never heard of your Second Report before. —W. S. P. (The other answers are to the same effect).

4—At least $150,000.—W. S. P. The damage done this year was immense, especially in the western half of the county. Half my corn crop was destroyed.—J. W. G. Impossible to give an estimate. They have almost ruined the farming interest in this county and State.—J. A. M. Two-thirds of crops ruined.—W. J. G. I would guess about $500,000.—DR. J. L. G.

Jasper County.

3—There have been no efforts made to overcome the Chinch Bug, except ditching between wheat and corn. By this means they have been kept off of corn for a time. We plow a deep and narrow ditch; then drag a round log back and forth in it to pulverize the dirt and wallow them in the dust, and if the weather is hot they die by the hundred thousand in these ditches, at noon day, especially if these ditches run north and south; but as soon as a sprinkle of rain comes so as to settle the dust, they cross over. In the meantime, the old ones are flying where they please, depositing their eggs, which soon hatch out. So you see by ditching we only save a few rows of corn from being killed outright. I have no idea of the extent of your Second Report among the farmers of this county.—J. M. P. No efforts have been made to destroy them, except to plow ditches and dragging logs in them. I have never seen your Second Report, nor can I learn of any one that has. * * *—T. M'W. (The other answers are to the same effect).

4—I cannot give approximately the damage done in this county this year by this insect. Suffice it to say, the damage is immense. * * *—J. M. P. In 1874 corn was not over one-fourth of a crop (if that) on account of drouth and bugs.—J. U. T. Wheat being very early in 1874, was not injured much, but oats was, and corn, I might say, was destroyed by them and the dry season. * * *—T. M'W. As to the estimated damage the chinch bugs have done the past year, I am unable to say, but will say our corn was almost an entire failure, a great many not raising a bushel, and none making a full crop; but the drouth was severe, and all other crops were hurt by the bugs.—W. G. L. C.

Johnson County.

3—People have tried a great many remedies but have not succeeded in defeating the bug. Your reports have never been distributed in this county to my knowledge.—W. C. Few efforts have been made to overcome their injuries. Some have tried sowing hemp between the wheat and corn, but of no avail—as soon as they become winged they fly over it. * * * Some years ago I manured one acre of ground in the Fall, (there were two acres in the piece, half being manured,) and sowed it in wheat. The next Summer the bugs worked on the wheat very bad. The acre that had no manure they almost ruined; but the manured acre they did not hurt; it ripened right. The other was very badly straw-fallen, and was very much shriveled. I have heard of others doing the same thing, and having the same success. In some parts of the county they have stopped raising wheat entirely, thinking to starve them out in the early part of the season, so they cannot increase before harvest, and by so doing, we will get rid of them in a few years.—J. L. M.

4—About 50 per cent.—C. J. C. Five hundred thousand dollars won't cover the damage in Johnson county last Summer. The greatest damage was done by what is termed the second crop, depleting the corn before it matures.—J. M. M. I don't think that the damage done in this county this year would fall short of half a million of dollars, from the fact that half the wheat and almost the entire crop of corn was destroyed or badly injured. * * *—W. C. There is not a farmer that will make both ends meet in all this county. Many will be bankrupt, *and all this by one little insect called the Chinch Bug.*—DR. D. Thousands of acres of corn were killed as dead as if burned—not a stalk left. They took three-fourths of the wheat crop, and about the same of the oats In the southern part they took all the wheat and oats, and they took also nine-tenths of the corn. There is a diversity of opinion as to the amount of damage done by them, varying from one and a half to two millions of dollars for all crops.—J. L. M.

Laclede County.

3—No systematic efforts have been made to overcome their injuries. They usually make their first appearance in the wheatfields, but in every instance where the wheat was sown sufficiently early to allow it to mature early, they have not done any serious damage to it, but late sown wheat has pretty generally been destroyed by them. * * * The 2d brood made their appearance promiscuously over the fields, and more especially in meadows that were cut early enough to admit the young grass to start up, when they soon kill it outright, both root and branch. * * * —L. R. R.

4—It would be utterly impossible for me to give approximately anything like a correct estimate of the damage done in the county by the chinch bugs either in the present or any previous year. It is ascertained that they will not depredate upon hemp, flax, castor beans, navy or other kinds of beans.—L. R. R.

Lafayette County.

3—No effort has been made to check it. I know of but one copy of your Report—J. B. No systematic efforts have been made at their extermination. I do not think your Report has been circulated or is much known.—J. E. G.

4—Have no idea of the damage done in this county.—J. B. It is conceded by every one with whom I have conversed on the subject, that the drouth cut off at least one-half from an average crop, and the bug certainly injured the remainder fully one-half. * * * Wheat was of very fine quality, and a good yield, being only slightly injured by the bug; the very late sowing worse than early sowing, in this part of the county. The damage to this county by the bug will not fall short of half a million dollars.—J. J. F. Putting drouth and chinch bugs together, they came near causing an utter failure, there being only about one-fifth of a crop of the grains, and that fifth of inferior quality. —J. E. G.

Lawrence County.

4—Cannot give the exact amount of damage done; corn is about one-half a crop. My opinion and that of many other farmers is that $100,000 will not cover the damage done by the bugs.—W. L. G. (Other correspondents put the loss of sorghum and oats at fifty per cent).

Lewis County.

3—No systematic efforts have been made. I have never seen your Report.

4—I should think that one-tenth would be a fair estimate, corn suffering the greatest; yet we raised a fine crop, superior to any we have had for several years.—W. B. D.

Linn County.

3—There have been no systematic efforts made to overcome the injuries of the bug that I have any knowledge of. As to your Second Report, I have never seen it, and do not think it is known among the farmers of our county.—A. M.

4—I think the damage by the bugs, irrespective of drouth, equal one-half of the whole crop. The wheat crop was not damaged by the drouth, and oats but very slightly, yet I think both damaged by the chinch bugs to the amount of one-third.—A. M.

Macon County.

3—No. Do not know anything about the Report referred to.—W. B. M. About one-fourth—all grains considered—of the crops lost.—W. B. M.

Madison County.

3—We have found out no means to exterminate them. We, however, have burnt stubble and in so doing have destroyed many of them.—J. M. A. It would be safe to say that our crops were cut short fully one-fourth this season by the bugs, except early wheat, which matured before the insect did much damage.—J. M. A.

Maries County.

3—There have been various plans adopted to subdue the insect: one way was to ditch and drag a log in it; another was to scald them; another was to scatter straw under and around the corn and set fire to the straw. This latter plan seemed to prove a success, but only for awhile—a heavy gale from the north blowing innumerable bugs over the cornfield. * * * I have heard nothing of your Second Report.—D. L. D.

4—I am not able to answer your fourth question definitely. Corn yielded about eighty per cent. less than the average, chiefly on account of chinch bugs and drouth; oats about fifty per cent. less; wheat was about twenty-five per cent. better.—D. L. D.

Marion County.

3—Two years ago I had wheat and corn in the same field, and when the wheat was harvested the bugs went into the corn. I let them have about a week to get a start in the corn, then I took a breaking plow and turned about eight rows of corn, bugs and all under, as deep as I could, and then put a heavy roller on it and rolled it thoroughly, and that was the last of those bugs, I think, as the corn was but little injured afterward. I have no idea to what extent your Second Report has been distributed in the county, but in this neighborhood there is nothing known about it.—J. K. M.

4—By consulting a number of the best farmers, we conclude the crops have been injured about one-fourth this year by the bugs.—J. K. M. I should estimate the damage done to the crops in this county alone this year to be at least $50,000.—W. R. A.

McDonald County.

3—There has been nothing of note done to prevent or destroy them. As for your Report I do not know of a single copy in the whole county.—W. D. P.

Mercer County.

3—No systematic effort has been made to overcome the bug or its injuries. Little or nothing is known of your Report of 1869, as but very few copies of the Agricultural Reports reach here.—J. H. B.

4—It would be a very difficult task to approximate the damage done by this *great pest.* In this county it may be put at $100,000 to $500,000.—J. H. B.

Mississippi County.

3—No. I do not know of any person that has received a copy.—S. S. S.

4—Impossible to make a truthful estimate.—S. S. S.

Monroe County.

4—It has damaged oats and corn one-half, wheat three-eights. Cannot give an estimate in dollars and cents.—J. P. M.

Montgomery County.

3—Fire is being used against them this Winter very much, burning old litter of all kinds. In Summer shallow ditches are made with the plow and logs and other weights dragged along those ditches to keep them from going in standing crops.—D. T. M. There have been no systematic efforts made to overcome its injuries. I do not think your Second Report has been distributed or known among the farmers of Montgomery county to any extent.—E. R. B.

4—From the best information I can get and from actual observation, I would say that the corn crop of the county was injured one-fourth. Wheat was less injured generally than for several years. I could not well approximate the damage in dollars and cents.—E. R. B.

New Madrid County.

3—No systematic efforts have ever been made to overcome its injuries. I do not think your Second Report is extensively circulated among farmers in the county.—J. S. B.

4—It would be impossible to give, even approximately, the damage done to this year's crop. It was comparatively slight.—J. S. B.

Newton County.

3—I think none at all. I have not even seen your Report before, and do not think there are many, if any at all, in the hands of farmers in this county.—J. T. No systematic efforts have ever been made to overcome its injuries. If any of your reports have ever reached this county, I have been unable to find one.—W. H. W.

4—It is very difficult to tell anything about the amount of damage, on account of the great drouth, but it was many thousand dollars.—J. T. They damaged the wheat about one-fourth, and killed nearly all the corn.—W. H. W.

Nodaway County.

3—While I was a member of the Twenty-sixth General Assembly, I secured about 40 copies of your Second Report from various sources and distributed them amongst our leading farmers and fruit-growers. These, I think, are about all that have been received in our county, although it has been eagerly sought for and fully appreciated by our people.—W. B. M. H. None. I think about one farmer in fifty has your report, and perhaps one-fourth have studied the insect's history.—W. P. Odessa Spring wheat is generally considered here as best standing their injuries, but has not been sufficiently tested to speak positively in regard to its merits.—T. D. W.

4—This year it damaged oats fully 3 bushels per acre, and Spring wheat 2 bushels; Fall wheat, rye and barley about 1 bushel per acre. The first crop of tame hay it did not injure, but the aftermath was cut short fully one-fourth ton per acre, and corn about 6 bushels per acre.—W. B. M. H. One hundred thousand dollars.—W. P.

Oregon County.

3—No. I have no definite idea, but believe there were very few copies distributed. —J. R. W.

4—About ten per cent.—J. R. W.

Osage County.

3—No systematic efforts to overcome their injuries have been made to my knowledge. Some have tried to keep them from spreading all over their farms by plowing and ditching, some by sprinkling a few rows of their corn in advance of them with a mixture of coal oil and water. It kept them from crossing for a few days, but did not prevent them from flying over and destroying the balance of the crop. Your Second Report was distributed among a limited number of farmers.—L. P.

4—The estimated damage done this year in this county by the Chinch Bug may be put down thus: wheat, one-fourth of the crop; corn, three-fourths of the crop; hay, one-half; oats, one-third—which would amount to several hundred thousands of bushels of grain, and several hundreds of tons of hay without the loss of meadows, for they have destroyed mine root and branch, besides a good many others.—L. P.

Ozark County.

3—None.—T. J. G.

4—About one-half the crops destroyed.—T. J. G.

Perry County.

1—We have been troubled with them for eleven or twelve years. Some years they do but little damage, and other years, generally dry seasons, they nearly ruin our crops, especially late corn. About five years ago the bugs were very bad and the next year we expected to have our crops entirely destroyed by them, but they had nearly disappeared. Last Summer they were very bad, it being a dry season, and they damaged corn very much; wheat being very early escaped their injuries.—R. M. B.

Pettis County.

3—None. I have never seen your Report; have tried to get it but failed.—L. H. W. No systematic efforts have been made to overcome its injuries. In regard to your Second Report, I have to say that probably not twenty copies have been distributed in this county. I never saw one, nor have I heard it mentioned by a single farmer of the county. Permit me to suggest that all your Entomological reports would be of vast importance to the farmers if placed in their hands, either with or without the Agricultural Reports. I have received two of them, and hoped to be able to secure them all as fast as published, but have been unable to do so.—O. A. C.

4—I think $5 per acre as the loss sustained by the corn crop alone would be a low estimate.—L. H. W. The damage done by the Chinch Bug alone is alarming; it cannot be less than $300,000, including damage done to all kinds of crops.—E. C. The damage done by them last year was great, but it is impossible to make anything like a correct estimate, as the drouth did greater damage, and both were upon us at the same time. In the south part of the county the oats and corn crops were entirely destroyed, while in the northern part of the county, where the soil is deeper, not more than one-fourth of a crop was raised.—O. A. C.

Platte County.

4—Not less than $100,000.—J. A.

Polk County.

2—But little damage was done to the wheat crop, but the oats, corn and Hungarian grass was badly damaged all over the county, and a great many fields entirely destroyed. * * * The farmers of this county are beginning to cut off their corn and pull the stalks whenever they can feed them to their stock, thinking in that way to destroy their eggs, which they think are deposited in the husks and blades, and in fact any kind of leaves or trash about the fences seem to be where they deposit their eggs. —J. C. [This is of course a fallacy.]

3—Plowing and dragging logs are the only means reported; and but few copies of the Report have been seen.

4—$500,000. Do not know as these figures are near large enough; would think $800,000 or $900,000 would be nearer the truth.—* * I think I am safe in saying that the entire grain crop of this county was damaged one-half by the bugs.—T. W. S. Wheat crop was not damaged much; corn crop almost a total failure.—M. D. M.

Pulaski County.

3—Nothing has yet been done to any extent to overcome its injuries. Your Second Report has been read by the reading farmers of my county; but a few copies have been sent us.—C. C. There have been no systematic efforts made to overcome its injuries. I have no idea to what extent your Second Report was distributed or known among the farmers in this county, but think there were but few distributed.—O. J. R.

4—Caused a loss to our county in corn, as near as I am able to calculate, of 132,750 bushels at fifty cents per bushel, $66,375. There is no doubt but that the hot winds during the second week in August and the drouth during the Summer had a serious effect upon the corn crop, but nothing to be compared to the injury of the Chinch.—C. C.

Putnam County.

3—No effort has ever been made to stay their ravages. The report of which you speak is probably oftener to be found among the books of professional men at the county seat than among the farmers.—A. D. T.

4—The damage by Chinch Bug this year was not, comparatively, great. It was confined to late sown wheat and late planted corn.—A. D. T.

Ralls County.

3—Nothing is known here of your Report. There are not more than three or four copies of that Agricultural Report in the county of Ralls.—A. E. T.

4—Injured crops 25 per cent. Saw a man who lives in Sny bottom; says prairie grass cut last year is so infested with chinch bugs the stock will not eat it, and some mules that eat it have died. I have seen in the last ten days any quantity of them sticking on the prairie fences and alive. Following your advice, I burnt some weeks ago 200 acres of rubbish on my prairie place, twenty-five miles from here, and hope I scorched some of the rascals. They are worse on prairie than timber land.—A. E. T.

Randolph County.

3—Do not know of any systematic efforts to overcome its injuries. Have never heard your Report mentioned in connection with it; do not know that any of the farmers of our county have seen the Report.—W. Q.

4—Would estimate its damage, the present year, in this county, at $20,000.—W. Q.

Ray County.

4—Corn, 50 per cent.; wheat, 25 per cent. * * ——. They did not injure the crops very much in this part of the county, but in the eastern and northern parts the amount of damage is at least from $25,000 to to $50,000. Not one-fourth of a crop of corn was raised there, and people will have to suffer.—J. M. B.

Ripley County.

3—No efforts made to overcome its injuries in any shape or form. Your Second Report went into the hands of about one farmer out of every fifty. You may justly suspect we know but little about it.—R. H.

4—The damage in my county I could not approximately say less than $40,000, all crops considered.—B. H.

St. Charles County.

3—No systematic effort made. Some tried hot water, others coal oil, and still others tried to stop them by ditching across the field. Your Report of 1869 is distributed in the county to about the number of thirty, as near as I know.—C. W.

4—By information gathered, I can safely estimate the damage done by the bugs in this county last year at $25,000, which is very low.—C. W.

St. Clair County.

3—Various plans tried, but without much effect. The distribution of your Report has been very limited in this county.—S. H. L. Although seemingly every effort has been made to subdue them, they have come out victorious—complete masters of the situation. Between them and the dry weather we have scarcely anything left to carry us through Winter. Many have despaired and left in disgust, others will remain and renew the combat. The Agricultural Reports spoken of were sent to the circuit clerk for distribution, and it is my opinion that they have generally been injudiciously distributed, finding their way to some favorite to fill up empty spaces in a book case, rather than to the farmer for whom they were intended. But your suggestions contained therein are becoming generally known among the farmers, and will be pretty thoroughly tested the coming season. The case has become desperate—something must be done or all is lost.—C. A. S.

4—The damage from Chinch Bug and drouth, in my township, was $15,000. There are twenty-four townships in the county; all did not suffer as much as this T. (31,) R. (28) west, but the damage may be put down at one-half on an aggregate.—S. H. L. An estimate of the damages done in the county of St. Clair, the past season, by these insects alone would be hard to even approximate. Owing to a combination of causes, wheat, oats and corn were almost an entire failure; three-fourths of which, however, might be attributed solely to the Chich Bug crusade, and the damage resulting therefrom could not fall short of a half million of dollars.—C. A. S.

St. Francois County.

3—Few efforts have ever been made to overcome its injuries. Some have tried to check them, when entering a corn-field from adjoining stubble grounds, by turning them under with a large plow; others, by letting them collect on a few of the first rows, and burning them with torches. Neither of these plans appear to be very effectual. A great many are destroyed to be sure, but enough generally escape to seriously injure the corn crops. The Report mentioned has had a very limited circulation. I don't know of any one who has ever received it.—E. H. P.

[The other correspondents make similar reports].

4—I don't know that I can give you even an approximate estimate of the damage done in this county this year by this insect. I believe there would have been double the corn, a fourth more wheat and oats, and, perhaps, a fourth more grass raised this season had it not been for the Chinch Bug.—E. H. P. Wheat only slightly damaged; corn very materially damaged.—A. J. L.

Ste. Genevieve County.

3—No great effort has ever been made to overcome its injuries as yet, with the exception of pouring coal oil on them, which destroyed both bugs and crop. As to your Second Report, there is nothing known of it here.—J. R. P.

4—This year the corn crop was injured fully one-half; wheat was affected in some places. Other crops were lightly dealt with.—J. R. P.

Saline County.

3—There has been nothing of any consequence done to destroy them. Your Report is received, for which I return my sincere thanks. I am sorry to say that there are comparatively very few of them in this county, and if the knowledge contained in them was universally known in this county, I am satisfied that it would enable us to meet our enemies, the bugs, determined to conquer.—J. P. M'M.

4—I cannot give the required estimate in regard to the damage incurred to crops. Suffice it to say that the chinch bugs and dry weather completely destroyed the oat crop and damaged the corn crop to the extent that there was not more than one-third of the amount raised as formerly.—J. P. M'M.

Scotland County.

3—Not many copies of your Second Report have reached this county.—A. N.

4—I don't hardly know what to estimate the damage done in this county the past season, but I think $100,000 will not fall short of it.—A. N.

Scott County.

4—Their damage in this county approximates $50,000.—H. P. L.

Shelby County.

The crops suffering most are wheat and corn. * * * I have noticed when the wheat covers well the ground (which it may be made to do by thorough manuring) in the Spring, so as to almost exclude the rays of the sun, the chinch bugs do not gather to raise their young there, but seek more open grain. If oats are sowed early and thick, and make a strong, vigorous growth, I have never known the Chinch Bug to hurt them, but if they are thin on the ground, admitting the rays of the sun freely, then oats are a fine crop to raise chinch bugs in. * * *.—J. B. R.

3—No systematic efforts made. I have not been able to hear of the first copy of your Second Report. I suppose they were sent to the county seat and distributed among those living near there.—J. B. R.

4—Cannot give you, with any great certainty, the damage our crops have sustained from chinch bugs the past year, but would suppose the damage to amount to about one-fifth of the value of the crops thus affected.—J. B. R.

Sullivan County.

3—Never saw your Second Report, or saw any person who did see it. The best thing, in my opinion, and it is simply my opinion, is to manure the points and other poor places and burn up the trash around the field and in the fence corners early in the Spring. They never injure a crop on rich land and growing thrifty, as they do on poor land. You would certainly deserve the gratitude of the people of Missouri if you could do anything to relieve them of this pest, or by studying its habits teach us to exterminate them. * * * —S. B.

4—Impossible to estimate.—S. B.

Taney County.

3—None have been made. But very few copies of your reports have been distributed —20 copies perhaps.—J. J. B. There have been no efforts made to overcome its injuries. Your Second Report has been distributed over the county by the State, but not to an extent that one-tenth of the farmers might read it.—W. R. H.

4—I cannot make anything like a close estimate of the value of the produce destroyed, though I should judge that it would amount to $20,000 to $30,000.—J. J. B. * * * From careful calculations, I conclude that Taney county lost over $45,000 by this insect in 1874. These calculations are based upon the census report of 1870 and the assessor's report of 1874. These figures are enormous, and by some may be considered extravagant, but if any one will visit our county and see the state of affairs—starvation staring everybody in the face, stock dying, etc., etc., the effects of dry weather and chinch bugs—they may be convinced.—W. R. H.

Texas County.

3—Some have tried scalding on a few favorite plants; it kills the bug and does not hurt the plant. No other systematic efforts have been made.—R. S. S.

4—I cannot give an estimate of the damage done; say one-half oats, corn and sorghum.—R. S. S.

Vernon County.

3—None whatever. Think there are not more than two or three of the Reports mentioned in the county.—J. A. P.

4—From all the information I have been able to gather in regard to the damage done by this insect, I do not believe it would fall far short of half a million dollars, all crops considered; and if we take into consideration the loss to farmers on account of stock, another half million dollars might be added, as farmers were compelled to sell their stock at a great sacrifice for the want of feed to make them ready for market, or put them through the winter, all of which is chargeable to the Chinch Bug, for although we had a very dry season, yet we would have harvested at least ninety per cent of a corn crop, and there would have been an average yield of wheat and oats.—M. L. M. It is impossible, at this time to closely approximate the damage in dollars and cents sustained by them this year, but may safely place it at one-half of the entire wheat, oats and corn crop of the county, for notwithstanding the drouth which prevailed, we certainly would have harvested a full crop of wheat and oats, and one-half of corn.—J. A. P.

Warren County.

4—Can't make any estimate in figures; would say about 50 per cent. on all uplands; on creek and river bottom lands the damage has been small.—D. P. D.

Washington County.

3—No efforts made to overcome them; very few of your reports in this county.—W. R.

4—As to the damage done by them it is hard to determine; we raised about one-fourth of a crop of corn and oats, and it is the opinion of our best farmers that the bugs hurt it much more than the drouth. Wheat escaped pretty much, as it was very forward. * * * —W. R.

Wright County.

3—There have not been any systematic effort made as yet. We know nothing about your Report. * * *—E. B. G.

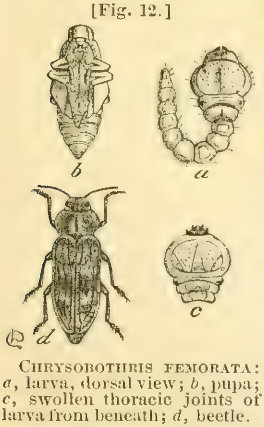
4—Corn is damaged, I think, probably, one-third; oats the same; wheat so little I could not estimate it. I have no way of getting at the amount in dollars and cents, but it is immense. My opinion is that Fall plowing, thorough cultivation of the land, and as early planting and seeding as possible, will in a great measure overcome their ravages; such has been my experience.—E. B. G.

THE FLAT-HEADED APPLE-TREE BORER—*Chrysobothris femorata* * (Fabr.)

(Ord. COLEOPTERA; Fam. BUPRESTIDÆ.)

This insect, owing to the enfeebled condition of many fruit and shade trees—a condition superinduced in part by excessive drouth, in part by defoliation, in the country ravaged by locusts—has been exceedingly injurious all over the western portion of the country. Specimens and complaints have reached me not only from many parts of Missouri, but from Iowa, Kansas, Arkansas, Texas and Nebraska; while the injurious work of this borer was so apparent wherever I traveled that I deem it advisable to publish a more extended account than was given in the Report for 1868.

[Fig. 12.]



CHRYSOBOTHRIS FEMORATA: *a*, larva, dorsal view; *b*, pupa; *c*, swollen thoracic joints of larva from beneath; *d*, beetle.

Considering the fatality of its work and the number of valuable fruit and shade trees which it attacks, few insects are more to be dreaded than this same Flat-headed Apple-tree Borer.

* Crotch in his *List* makes *alabamæ* Gory, *4-impressa* Gory, *Lesueuri* Gory, *fastidiosa* Gory, *soror* Lec., *misella* Lec., *obscura* Lec. and *semisculpta* Lec., varieties or synonymes of *femorata*. My own experience so far as it goes in breeding this insect from different trees bears out Mr. Crotch's opinion.

Our oak trees die from year to year. Inquire the cause: The answer is: "O, they cannot stand the influences of civilization!" Search for it yourself and you will find that Chrysobothris has had more or less to do with their death. The townsman prides himself on the thrifty growth of his soft maples or sycamore trees that are to give him shade from the midsummer sun, adorn his lot or line the front of his city residence. After a thrifty growth of two, three or more years, one of the trees suddenly dies, and others soon follow. The cause is discussed: Drouth, packed soil, poor nourishment and a dozen seemingly plausible reasons are conjured up, and ashes, or some other mineral or vegetable substances are placed around the butt in the vain effort to save the remaining trees. Pull off the bark, however, and the real cause is readily discerned, for the surface of the hard wood is literally covered with broad, shallow channels packed with sawdust like casting—channels which Chrysobothris, unseen and unheard, has been making, perchance, since the tree was first set out. Mountain Ash, Linden, Box-elder, Beech, Plum, Pear, Cherry and Peach alike succumb to its attacks,* while the Apple is so subject to its injuries that no man who does not understand this enemy and is not willing to give some little time to mastering it, can hope to succeed in growing apple trees in Missouri; and in reality the time and money spent in planting young apple orchards, especially in the western part of the State, is generally wasted for want of the necessary precautions against this insect.

ITS NATURAL HISTORY.

The natural history of this borer is thus briefly told: The beetle, known as the Thick-legged Buprestian, is very variable in size (my figure at *d* representing a large one), and has been described under a number of different names. It is greenish-black or bronze-colored, with metallic reflections and the underside more coppery or brassy. The more characteristic features are two irregular, impressed, transverse marks across each wing-cover, dividing them into about three equal lengths. This beetle, like all the species of the family (*Buprestidæ*) to which it belongs, is diurnal in habit, and may frequently be found basking in the sun on the trunks of those trees which it more particularly frequents. It begins to appear during the latter part of May and is found all through the Summer months. The eggs, which

*I have reared the beetle from Oak, Apple, Mountain Ash, Box-elder, Peach and Pear, and found the larvæ, judged to be the same after critical comparison, in the other trees mentioned.

are pale yellow, and irregularly ribbed or corrugated,* are glued by the female by preference under the loose scales or within the cracks and crevices of the bark, several of them being not unfrequently found together. Yet they must also be laid at times on perfectly smooth bark, as I have found the newly hatched larva in such bark, and under circumstances that would indicate that the beetle sometimes uses her jaws to puncture the tender bark so as to allow the insertion of the egg. The young larvæ hatching from them gnaw through the bark and feed upon the fiber, boring broad and flattened channels, and very soon girdling the smaller trees. When its jaws get stronger it usually bores into the more solid wood, working for awhile upward, and when about to transform it invariably cuts a passage back again to the outside, leaving but a thin covering of bark over the hole. It then retreats, and after packing the excrement around it so as to form a smooth cavity, changes to the pupa state (Fig. 12, *b*). The pupa at first white, by degrees exhibits the colors of the future beetle, and in the course of about three weeks the latter gnaws its way through the thin bark door which, as larva, it had left closing its passage-way. It is a singular instinct that thus teaches the larva, which has powerful jaws, to prepare for the exit of the beetle, which has much more feeble ones; and this instinct is most strikingly illustrated when the infested tree is surrounded with some covering like wire gauze, which is proof against even the jaws of the larva. In such an event, even though the wire touch not the bark, the larva will work its way through the latter, and test in every conceivable way the resistance of the wire, and frequently succumb in the effort to penetrate it. Yet normally this same larva would take every precaution not to penetrate the bark.

Whether this borer remains in the tree nigh upon one or two years after hatching, no one has definitely determined. The general impression is that it acquires its full development in a single year. Be this as it may, the larvæ are found of different sizes during the late Summer, and young ones may be noticed even in Winter. In May they are mostly found full grown or in the pupa state. The figures which accompany this article will sufficiently illustrate the appearance of the insect in all its stages, no drawing of the pupa having ever been made before.

NATURAL ENEMIES.

Hidden as this borer naturally is within the retreat of its own

* Eggs which I have found on apple trees, and taken for those of this insect, and which accord in appearance with those taken from the abdomen of the female beetle, are about 0.02 inch long, ovoidal, with one end flattened; the shell very thin, and irregularly ribbed.

making, it is nevertheless hunted and destroyed by wood-peckers, and is not without its insect parasites. Already, in 1856, Dr. Fitch, in his first report as State Entomologist of New York, mentioned having received from that veteran nuseryman, Mr. P. Barry, specimens of the larvæ which had been entirely devoured, so that nothing but the shrivelled skin remained, by a number of small dull whitish grubs, about one-tenth of an inch long, belonging, in all probability, to the *Chalcididæ*, an extensive family of small, parasitic, wasp-like insects; and this Fall I have received what are evidently the same Chalcid larvæ from Mr. R. H. Titts, of Lawrence, Kansas, who gives the following interesting account of their work:

The first time we observed these parasites here this season, one of my neighbors remarked that he thought that there was a mistake about a beetle laying the egg that produced the borer. In hunting borers on my own place shortly after I found some of them were sickly or stupid and of a peculiar yellowish color, different from natural. One of these that I had not injured I left in the cavity where found, and closed up the bark, fastening it with wax. After about ten days, on opening it again, I found the parasites at work and the borer dead and partly eaten up; after which I found them frequently in different stages of growth, till the borer was all consumed and the parasites were of the size of those sent you. Those were taken from a cavity with nothing but a part of the skin of the borer left. I did not find them again until about September 1st, after which time I think but few if any borers escaped them. I stopped hunting borers after September 15th, satisfied that the parasites were doing a better job than I could. Others in this section are doing the same. I think that although the borers were much more plenty this season than last there will be less beetles perfected to issue than last year, on account of the parasites. In digging borers I found that if the mouth of the hole in which they had entered the tree was opened the ants would go in and destroy and carry the borer away in every instance, even clearing out the sawdust to get at them.

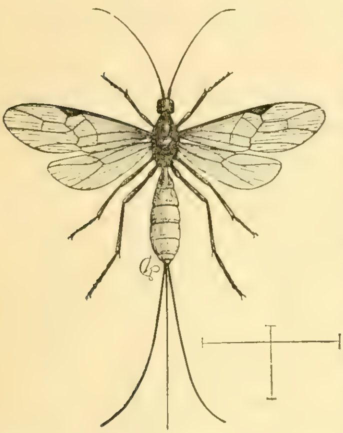
The following letter, received from Mr. C. R. Hoag, of Sedalia, the fore part of December, was accompanied by the same parasite:

Inclosed I send you the larva of an insect unknown to me; it is the second lot that I have found in a precisely similar situation. I send them in the dust or borings in which they were found; they were found in an apple tree in the bed of the Flat-headed Borer, after he had penetrated the solid wood of the tree. The borer had evidently been destroyed by the small larva, as there was in this latter instance no part of the borer to be found, and in the former but small portions of the skin partly surrounded by the small maggots. I am in hopes that they may prove to be the larva of an insect that is a common enemy to the most destructive pest of the orchard. The ravages of this borer during the past season, in this part of the country, have been unprecedented; it has been a great deal more numerous than the Saperda or Round-headed Borer, that works near the ground. Heretofore (in my experience) they have seldom attacked a healthy and thrifty tree, but have confined their ravages to trees that have received a severe check in transplanting and in bad usage generally. During the past season they have attacked the healthy as well as the unhealthy trees.

I have not succeeded in rearing the perfect fly from these small maggot-like larvæ, but there can be no doubt that it will prove as Dr. Fitch surmised, to belong to the *Chalcididæ*, an extensive family of small 4-winged flies of black or metallic colors, ever on the alert for prey, and sometimes attacking the vegetable feeders at first hand, but more often acting as secondary parasites. In the present instance the minute mother fly must manage to insinuate herself in the burrow of Chrysobothris, and, having reached the borer, pierce the skin and consign her eggs in its body.*

I have bred two other much larger parasites from this borer, both of which belong to the large family of Ichneumons, and reach the borer by means of a long sting or ovipositor. The first of these, which may be called the Cherished Bracon is an undescribed four-winged fly, with the head, thorax, antennæ and legs polished black, the abdomen coral-red, and the wings deep smoky-brown. It expands about 0.65 inch, the body has a length of 0.35 inch and the ovipositor of 0.40 inch. The sting or ovipositor consists of a pale yellow, central terebra, and two stouter black sheaths. The larva, after destroying its victim, spins a yellowish-brown cocoon, flat on two sides, and not unlike a miniture coffin, and the perfect fly issues in Spring through the burrow which the Chrysobothris would have used had it been allowed to live. This parasite is quite common, and though I have reared it on three different occasions, it was in each instance parasitic on Chrysobothris. Specimens sent to the well known Hymenopterist, E. T. Cresson, two years since, were pronounced new, and as no American species of the genus have since been described, I append a description:

[Fig. 13.]



BRACON CHARUS:—Parasite of Chrysobothris.

BRACON CHARUS, N. sp. (Fig. 13)—♀ Length of body 0.35 inch; of ovipositor 0.40 inch; expanse of wing, 0.65 inch. Colors black and deep rufous. Head, thorax, legs and antennæ polished black, the legs and sides of head and thorax with a fine grayish pubescence; trophi also black. Abdomen uniformly deep rufous. Terebra of ovipositor pale yellow, the sheaths black and very faintly pubescent. Wings deep fuliginous with a faint zig-zag, clear line across the middle from the stigma.

Described from 7 ♀'s, all breed from *Chrysobothris femorata*.

The other Ichneumon-fly is somewhat larger, and may be called the Useful Labena. It is the *Cryptus grallator* of Say, subsequently described as *Mesochorus fuscipennis* by Brullé, and belongs to the modern genus *Labena* Cresson. Its body is half an inch long, but the ovipositor has only a length of 0.30 inch. The general color of the body is honey-yellow inclining to brownish, and the wings, which expand nearly an inch, are clouded each with two broad, smoky-brown

* As this Report is going through the press, my friend, A. S. Fuller, of Ridgewood, N. J., sends me a number of these Chalcid maggots that have preyed on the Chrysobothris larva, and which he received from Prairie City, Mo.

patches, the light parts being hyaline. The antennæ are reddish-brown, yellow beyond the middle and dark brown toward tips; the ovipositor has the terebra dark and the sheaths yellow with dark brown extremities. Full descriptions of the species under the name of *Labena grallator* have been published by Mr. Cresson* and by Mr. Walsh,† who bred it from hickory wood infested with the larva of *Cerasphorus cinctus*, a longicorn beetle. This fact shows that the Useful Labena is not confined in its attacks to the larva of Chrysobothris, as the other species seems to be. I bred this fly from a Chrysobothris larva infesting an apple tree. It was handed to me by Mr. W. W. Tipton, of Burlington, Kansas, just as it was spinning a delicate transparent cocoon, and Mr. T. felt sure that he had made a grand discovery, and that entomologists had all been wrong in not stating that the flat-headed apple tree borer makes a cocoon. Persons unfamiliar with parasitism in the insect world are apt to jump to such hasty conclusions; and it is only necessary in this connection to say that the Chrysobothris *never does make a silken* cocoon, and that whenever such is found in its burrow, its contents should not be crushed, but allowed to mature and escape.

Where the Chrysobothris breeds in felled oak logs or in stumps, it is often destroyed by ants, and they doubtless frequently reach it even in growing trees, especially when the entrance is exposed, as just described by Mr. Titts.

REMEDIES.

In treating of the means to be employed against this Flat-headed borer, one important fact should be borne in mind. The natural breeding place of the insect is undoubtedly in the old decaying oaks of our woods, and I have known it to swarm in old post-oak stumps from which the tops had been felled for a number of years. In fact it prefers partially dead or injured trees to those which are thrifty and vigorous, and partly for this reason, and partly because rough, cracked bark forms a better nidus for the female to lay her eggs, the species is most abundantly found on the southwest side of young apple trees where they are most apt to get injured by sunscald. Sickliness in the tree, injury from the whiffletree or other cause, therefore, predispose to its attacks. It is for this reason that transplanted trees, checked as they are in their growth, usually fare badly. But there is yet one other predisposing cause which few people suspect, and that is reck-

* Proc. Phil. Ent. Soc. III, pp. 400-1.

† Trans. Ac. Sc. of St. Louis, III, pp. 162-3.

less and careless pruning, especially of the larger branches. Many a fine orchard tree, and many more city shade trees receive their death shock from the reckless sawing off of limbs without effort being made to heal the wounds by coating with grafting wax, clay or other protecting substances. Around such an unprotected sawed limb, as around the frustum of a felled tree, the rain and other atmospheric influences soon begin their work of causing decay between the bark and the solid wood; and this is but the forerunner of greater injury by insects which are attracted to the spot, and which, though hidden meanwhile from view, soon carry the destruction from the injured to the non-injured parts. Among the insects thus attracted, Chrysobothris plays no mean part, where, had the wounded limb been properly protected, its presence would never have been known. It thus becomes of the first importance, in treating this insect, to keep the young trees vigorous and healthy, and the bark as smooth and as free from injury as possible. Thus in planting a young orchard in this part of the country, where the sun (whether indirectly or directly is for the vegetable pathologist to determine) is apt to injure the bark on the southwest side, it will prove labor well spent to protect them on that side by old paling or lath. Young trees are far more liable to be attacked than old ones, and consequently require greater care.

A healthy and vigorous tree is not chosen by the female, in depositing, if unhealthy or injured trees are at hand; and when eggs are deposited in trees of the former character, the young borers more often perish—are drowned out. Yet it must not be supposed, on this account, that the insect cannot live in a healthy tree, for he who should act on this principle and take no other precautions against its attacks than good cultivation, would too often discover his mistake. That the insect is seldom if ever found in healthy trees is a necessary truism which often deludes into belief that it cannot attack such. As soon as the borer is at work the tree ceases to be healthy; and while careful culture and protection from other injury are excellent preventives against its attacks, they are not infallible.

As a preventive against the insect's attacks there is nothing better than coating the trunks and larger branches with soap at least twice a year, once toward the end of May and again in July or August. The soap is not only obnoxious to the beetle, but it tends to keep the bark clean and smooth, so as to offer no attraction to the female, and is, withal, beneficial to the tree.

Mr. Henry Shaw, who has had a good deal of trouble from the work of this borer on the young trees in Tower Grove Park, St. Louis, has finally painted them with a mixture of soap, lime and a small proportion of Paris Green. The Green might, I think, be dispensed with, but the lime gives consistency as well as persistency to the soap, and in many of the trees thus treated the larvæ have actually worked their way out only to fall to the ground and perish. A small proportion of glue dissolved in the mixture would add still more to its persistency, and, being gradually dissolved by the rains, not injure the tree.

Other substances have been applied to trees as preventives of the attacks of this insect, and right here the question is naturaly asked, "does it hurt trees to grease them?" The question has been discussed for many years by horticultural bodies, and the individual experience is always conflicting. Indeed, it only admits of a conditional answer, as so much depends on the quality of the grease and the time of year in which it is applied. All greasy substances of such consistence that they will effectually preclude the air for any length of time must necessarily be injurious, whereas, if they soon evaporate or crack open they may be applied so as to produce no injurious effects. Kerosene and axle grease have been used by several prominent Kansas fruit-growers, without injury to the tree, and with satisfactory results in keeping off both borers and rabbits. Coal tar has also been used for the same purposes, and with satisfaction, by many, and is now being extensively tried in the college orchards at Manhattan, and by H. E. Van Deman of Geneva, and others; while pitch tar applied direct to the tree is generally injurious.

From what has already been said we see the importance of keeping the bark smooth, whether by the use of soap or by scraping. The former mode of keeping the bark smooth is altogether preferable, not only because it is more obnoxious to the beetle, but because it is less hurtful to the tree. For it is a fact, exemplified in the experience of Mr. Wm. R. Randall, of Washtenaw county, Michigan, as communicated to the *New York Tribune*, that in scraping trees or in using a knife to cut off the loose bark, the fresh bark is often abraded and bruised so as to form just the nidus needed by the beetle. And Mr. Randall found that the very parts which he had left exposed in this manner by Summer scraping were afterwards well supplied with borers. Scraping, therefore—if it has to be done—should be done early in Spring, before the beetle appears, so that any unavoidable bruising may have time to heal before Chrysobothris is seeking to deposit her eggs.

In Chicago, since the great fire of 1871, a large business has been done in transplanting from the woods immense shade trees, some of them over a foot through. The Flat-headed Borer is playing havoc with many of them, and in despair some of my friends have been at the trouble and expense of wrapping the entire trunk and the larger branches in wire gauze, through which the beetle cannot penetrate. This gauze, if so hung that no part of it touched the bark, would undoubtedly prove a perfect protection ; but as it is tacked on, it does not necessarily prevent the female beetle from consigning her eggs to the bark, however much it may prevent the insects already in the tree from issuing; while the cell growth of a single year is very apt to burst it in many places.

But whatever preventive measures be taken, trees should be carefully examined late in the Fall. At this season, or even in the Winter time, the young borers which have just commenced work, are easily detected and destroyed by a knife before they have done much harm. Trees presenting those conditions which I have already stated to be attractive to the insect should be especially watched, and any tree that is suddenly checked in growth should be attended to, as it will probably be found to contain the borer, though the outward signs of its presence may not at first be so manifest. There is a very general impression, also, among orchardists, that this insect is more injurious on low lands than on high lands, and orchards on low land should be more particularly watched.

The presence of the young borer is usually indicated by a discolored spot, a cracking of the bark, or the presence of saw-dust like excrement. It will pay to look over the trees even before Fall, for as early as the latter part of June, in the latitude of St. Louis, the newly hatched worm may sometimes be found just entering, when its presence is frequently indicated by an exuding drop of moisture on the bark, and when it may be destroyed by cleanly cutting out a small slice of bark. Indeed, I would earnestly commend the following advice of Mr. A. A. Briggs, of LeRoy, Barton county, who, after informing me that he has taken out as many as a hundred borers from one small tree, says:

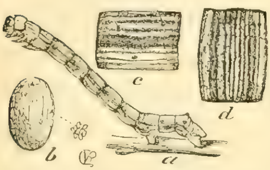
> It is best for those having trees subject to attacks, to look over them every week if possible, or every two weeks at least, from the first of June to Fall, for exudation of sap from the bark, which is a sure indication of their presence. Carelessness in this respect the past season has cost me more than 300 trees, all young.

It is useless to spend time in trying to reach such borers as have already penetrated into the solid wood. They are with difficulty attained, and have already accomplished their principal damage.

CANKER-WORMS.

In further illustration of the remarks made last year on the two species of Canker-worm which have very generally been considered mere varieties of one species, and about which there has been no little confusion,* I have prepared figures of each, which, in connection with a few explanatory remarks, will enable their ready distinction.

[Fig. 14.]



SPRING CANKER-WORM:—*a*, full grown larva; *b*, egg, enlarged, the natural size shown in the small mass at side; *c*, an enlarged joint, side view; *d*, do., back view, showing the markings.

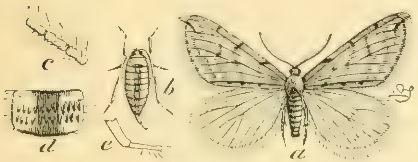
THE SPRING CANKER-WORM (*Anisopteryx vernata*, Peck, Figs. 14, 16. This species, which, from the fact that the great bulk of the moths issue from the ground in early spring, may be distinguished from the other by the popular name here given, is the true Canker-worm originally described, as *Phalœna vernata* by W. D. Peck in 1795. This is undoubtedly the species for the most part spoken of in the agricultural journals of the country, and the species best known in the Mississippi Valley.† This Spring Canker-worm is distinguished, in the light of recent careful discriminations, by the characters indicated last year, viz.: by each of the first seven joints of the abdomen in both sexes bearing two transverse rows of stiff, red, or reddish-brown, posteriorly directed spines; by the front wings in the male having three transverse, dusky lines, and a somewhat broader, jagged, pale submarginal line; and by the whole body in the female,

* This confusion is in part due to the fact that Harris, in his work on Injurious Insects, in treating of THE Canker-worm moth, describes at length, not the species first called the Canker-worm by Peck, but the larger species (*pometaria*). He then uses the following language: "Specimens of a rather smaller size are sometimes found, resembling the figure and description given by Prof. Peck, in which the whitish bands and spots are wanting, and there are three interrupted, dusky lines across the fore-wings, with an oblique, blackish dash near the tip. Perhaps they constitute a different species from that of *the true Canker-worm moth*. Should this be the case, *the latter* may be called *Anisopteryx pometaria*." The term "true Canker-worm" is here misleading, as, while it should evidently apply to the insect originally described by Peck, Harris really applies it to the other species, for which he suggests the name *pometaria*. It is this ambiguity which originally led Mr. Mann to confound the two species, and which led me to make the remarks in the first paragraph on page 29 of my last Report, which—founded on a misunderstanding of Harris's meaning—should be cancelled. As I have already stated, the descriptions in my Second Report are of *vernata*, but the poor figures, which are copied, represent neither species properly, though those of the moths are of *vernata* and those of the eggs *pometaria*. Harris's descriptions of the moths and eggs are of *pometaria*, but those of the larva, and probably of the chrysalis, are of *vernata*.

† There is in fact no evidence that the other species *pometaria* occurs at all either in Illinois or Missouri, since an examination of the specimens in Dr. LeBaron's cabinet and in my own, proves them all to be the true or Spring species. Indeed, until I received specimens of *pometaria* from Mr. H. K. Morrison and Mr. B. P. Mann, I had never seen the species—the male specimens which I mistook for it in former years being in reality specimens of *vernata* which approach it in the markings of the front wings. That it occurs in the Southwest is, however, proved by the fact that Dr. Packard informs me that he has a fine typical specimen from Dallas, Texas, collected by Mr. Boll.

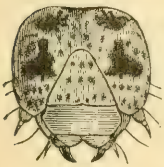
as also the legs and antennæ, being pubescent with pale and dusky hairs—the color being rabbit-gray, or speckled black and white, the abdomen having a medio-dorsal black stripe. The dusky stripes on the front wings of the male, except at costa, and the black stripe on the abdomen, except at each end, are usually more or less obsolete, and indeed the ornamentation of the wings is extremely variable. In many specimens the middle portion of the front wings, within the three dusky lines, is quite pale and mottled with grayish-green, while the basal and terminal portions are marked with brown, thus making the contrast greater. Others again are absolutely without marks whatever, even when fresh from the crysalis; while captured specimens always have the marks more or less effaced on account of the looseness of the scales. The moths rise from the ground for the most part early in Spring, and only rarely the previous Fall. They are crepuscular in habit, and are most active soon after dark in the evening. The female by means of a horny and extensile ovipositor thrusts her eggs, to the number of from 50 to 150, under the loose scales of bark or in any crevice or sheltered place, and is very fond of availing herself for this purpose, of the empty cases of the Rascal Leaf-crumpler* (Rep. 4, Fig. 18.) The eggs are but slightly glued together, and have the form of a rather elongate hen's egg, the shell being very delicate and smooth, though often appearing roughened by transverse and longitudinal, irregular depressions. The larva has but four prolegs, is variable in color, and one of its distinguishing characters is the mottled head (Fig. 15.), and two pale narrow lines along the middle of the back, the space between them usually dark and occupied on the anterior edge and middle of joints 5, 6, 7 and 11 by black marks somewhat in form of X; these marks being represented by dots on the other joints. There are two rather prominent tubercles on top of the eleventh joint, preceded by two white spots. The chrysalis, so far as my comparisons have enabled me to judge, does not differ materially from that of the other species, so that the two species could hardly be distinguished in this

[Fig. 15.]



SPRING CANKER-WORM :—*a*, male moth ; *b*, female do.—natural size ; *c*, joints of her antennæ ; *d*, joint of her abdomen, showing spines ; *e*, her ovipositor—enlarged.

[Fig. 16.]



Enlarged head of Spring Canker-worm, front view.

* Senator Elmer Baldwin, an Illinois orchardist of large experience, as quoted by Dr. LeBaron (2d Ill. Rep. p. 106), found these cases so generally used for this purpose that he considered the gathering and burning of the cases one of the best means of destroying the Canker-worms. I can testify, from my own experience, to the frequency with which the cases are used as a nidi.

state. This is the species treated of in my second Report, and which so injuriously affects our apple orchards.

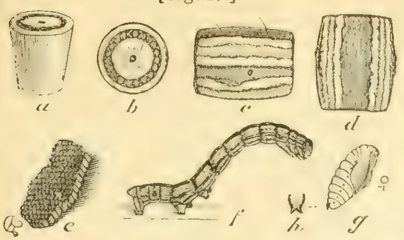
The following descriptions of the immature stages will serve to compare with those presently given of what I call the Fall Canker-worm:

ANISOPTERYX VERNATA, Peck.—*Egg*—Elliptic-ovoid; 0.03 inch long; not quite half as thick, appearing sometimes faintly shagreened, and with irregular, longitudinal depressions; reflecting prismatic colors; shell thin and delicate and quite smooth under the microscope. Deposited in various sized masses in sheltered situations.

Larva—When first hatched of a dark olive-green or brown hue, with a shiny black head and thoracic legs, with a whitish lateral and dorsal band, the latter having a darker central line along it. [These pale stripes are broad, and the dorsal one almost white on the anterior part of each joint, so that the dorsum often appears spotted.] After the first moult, the head becomes lighter and mottled, and the light bands less conspicuous. After the second moult, the bands are almost obliterated and the body becomes more uniformly mottled and speckled with livid-brown; the head becomes still lighter and the prolegs being now large, spread out at almost a level with the venter. After the third (and I believe last) moult, the appearance changes but little. The full-grown larva averages 0.90 inch in length, with an average diameter of 0.10 inch, being broadest on joint 11. It varies from light fleshy-gray to almost black. Head mottled as in figure 16. Ends of body somewhat darker than middle. Joint 1 with a yellowish dorsal shield, the hinder margin in form of a rounded W. Viewed under a lens, the body has a series of eight fine light yellowish, irregular, somewhat broken lines running the whole length of the body, each one relieved by a darker shade each side of it. The two along middle of dorsum are close together, with the space between them usually dark, and occupied at anterior edge and middle of joints 5, 6, 7 and 11 by black marks somewhat in form of x, or of a trefoil; these marks being represented by simple black dots on the other joints. Space between these dorsal lines and the next lowest, lighter, and containing four black piliferous spots to each joint, the posterior ones rather further apart than the anterior ones which on joint 11 form two larger elevated shiny black spots, [often with white spots in front of them.] Space between lines 2 and 3 darker than any other part of the body. That between lines 3 and 4 lighter than any other part of body, and containing the stigmata which are perfectly round and black with a light center, with a small piliferous spot anteriorly above and below them, and another behind them, this last becoming large on joints 5, 6, 7 and 8. Venter dark and livid at borders, with a pale greenish band along the middle, which has a pinkish patch in it on joints 5, 6, 7 and 8. Legs greenish at base; color of body at extremity. The markings are most distinct on the light specimens.—[Second Report.

Chrysalis—Pale grayish-brown, with a dark green tinge on the wing-sheaths. Remarkable for its robustness and for the large size and prominence of the palpi. A single bifurcate thorn at extremity. Length 0.35 inch; diameter across thorax 0.12 inch. (From the fact that in this description of the chrysalis, made six years ago, no reference is made in my notes to any sexual distinction, and that over a dozen chrysalis shells examined all show the wing-sheaths, I infer that the female chrysalis has wing-sheaths, as in *pometaria*, and that it otherwise, in this state, resembles this last.)

[Fig. 17.]

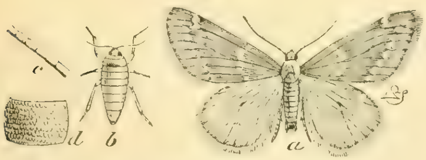


FALL CANKER-WORM:—*a, b*, egg, side and top views; *c, d*, joints of larva, side and top views, showing markings—enlarged; *e*, batch of eggs; *f*, full-grown larva; *g*, female chrysalis—natural size; *h*, top view of anal tubercle of chrysalis, enlarged.

THE FALL CANKER-WORM (*Anisopteryx pometaria* Harr., Figs. 17, 18.)—This insect is easily distinguished from the preceding, when critically examined. It is, on the average, somewhat larger and more glossy; the front wings of the male have a distinct white spot on the front edge, and are crossed by two pale, jagged bands, along the sides of which there are several blackish dots. The hind wings also have a pale, curved line, more or less distinct, across their middle. The female is uniformly dark ash-gray above, paler beneath, with the antennæ naked, and the legs and abdomen smooth and glistening, and with no extensile ovipositor. Thus it lacks the characteristic spines of *vernata*, the dusky marks across the front wings, and the pubescence in the female; and there are many other minor differences, which are mentioned in the tabular and comparative description of the two insects further on.

The moths rise mostly late in the Fall, but also during the warm weather of Winter, even to Spring. The eggs are tough, with a flattened crown of a purplish color, and having a dimple in the center and a brown ring near the edge: they are not secreted or hidden under scales, but are laid in regular and compact batches, of from 100 to upwards of 200, on the surface of twigs or of the trunk, being fastened by a strong glue, and covered with a slight coating of grayish varnish. The larva is distinguished from that of the Spring Canker-worm by having a dark brown back, and three conspicuous broad, pale

[Fig. 18.]



FALL CANKER-WORM—*a*, male moth; *b*, female do.—natural size; *c*, joints of her antennæ; *d*, joint of her abdomen—enlarged.

yellow lines each side, as well as by having a third pair of prolegs, shorter than the others, on the 8th joint. It develops very rapidly, entering the ground, with favorable weather, within three weeks after hatching; and, singularly enough, suffers but two molts, exclusive of that which takes place underground in transforming to the chrysalis. It is found principally on the Elm, and has not yet been reported from the Mississippi Valley. The female chrysalis is stout and has a little, decurved, bifid thorn on the tip of the body superiorly. It has perfect wing-sheaths, though the moth is wingless. The color is light brown with darker wing-sheaths.

ANISOPTERYX POMETARIA Harris—*Egg*—Length, 0.025 inch; average diameter ¾ the length; flattened at top where it is somewhat larger than at base. Color of crown purplish-gray, the surface slightly corrugated, with a central dimple and a brown circle just within the border; sides smooth and more silvery, and generally somewhat compressed by pressure of adjacent eggs. Laid in exposed situations, in patches or strips, attached in regular rows, and fastened to the bark in a slightly slanting position so that one edge of the crown is a little above, the other a little below the general level.

Larva—Color pale brownish, marked with dark brown and yellow as follows: The dorsum uniformly dark brown; the sides with three pale narrow lines, more or less irregular and mottled, but always well relieved, the two superior ones white, the lower most yellowish; the subdorsal space between the upper two of these lines, pale; the stigmatal between the lower two darker, especially in middle of the joint around stigmata; the thoracic joints dark with the pale lines somewhat narrower and running up to the head. On joint 11 these lines are constricted or entirely broken, so as to leave a dark band across the middle of the joint. The head is dark brown above and at sides, but paler in front. Cervical shield also dark with the yellow lines running through it. Venter olivaceous, the legs more reddish, there being three pairs of prolegs, the pair on joint 8 only half as long as those on 9, but with perfect hooklets; the thoracic legs quite hirsute and terminating generally in two thorns. Piliferous spots obsolete and with a very few scarcely distinguishable pale hairs, except on anal shield and legs, where they are stouter. Anal shield and legs with brown piliferous dots. The newly hatched larva is pale olive-green with a large pale yellowish head and pale legs. The light lines of the mature larva are, at this early stage, faintly indicated and the piliferous spots give forth short, fleshy, pale hairs. The third pair of prolegs is distinctly visible, but is not used in locomotion. After the first molt the head and thoracic legs become somewhat browner, and the olivaceous green more bluish. After the second molt, the dark colors show much more distinctly.

Described from numerous full grown specimens received from Mr. B. P. Mann, others received from Dr. A. S. Packard, Jr., and a larger number of all ages reared by myself from the egg.

It varies somewhat in intensity of color, and in some the light and dark browns are not so sharply separated, but the dorsum is generally uniform and the three lateral yellow lines distinct. Up to the second or last molt, the general color is, with rare exceptions, greenish; but in the last stage, the dark-brown or black predominates, and is sometimes so general that there is but the faintest trace of the superior yellow lines. Occasional specimens, even when young, show in the subdorsal dark space, one, and in the dorsal dark space, two, very fine and faint pale lines. Differs entirely from *vernata* in lacking most of the characteristic spots in front of the head of that species, and the two pale transverse marks; in having the dorsum darker instead of lighter than the rest of the body; in lacking the medio-dorsal pale lines and the characteristic x-like marks; in the broader, more conspicuous pale lateral lines, and in the subdorsal space being darker than the stigmatal; and lastly in the additional, though atrophied, abdominal prolegs. It is a smoother larva.

Chrysalis—Color light brown, with the wing-sheaths, a medio-dorsal shade, sutures and stigmata darker. Length 0.30—0.35 inch; stout, with the wing-sheaths and their veins distinct in the female; a dorsal, bifid, decurved tubercle near the tip of anal joint.

PRACTICAL CONSIDERATIONS.

The practical man may consider the illustration of these differences as unimportant and trivial, however much they may interest the entomologist. Yet it is of much practical importance to know how to distinguish between these two insects. From present knowledge of the subject, it is highly probable that, just as the moths of the one species appear mostly in early Spring, and of the other mostly late in the Fall, so each is, in a general sense, confined to particular plants—the Spring species preferring our fruit trees, and the Fall species preferring the Elm. Thus the time to put forth our efforts to catch and destroy the wingless moths will vary according to the nature of the tree to be protected and the insect to be dealt with.

In the case of the Spring species, the scraping of loose bark from the tree and otherwise cleansing it of dead leaves, cocoons, larva-cases, etc., a short time before the hatching of the worms, or before the buds of the tree commence to open, will prove an effectual preventive measure; as thereby many of the eggs will be destroyed. Moreover, a tree kept clean of loose bark will be less subject to its attacks. The same argument will not apply to the Fall species, which attaches its eggs in any exposed position. It would seem, also, that the mode of trapping the moths will have to be somewhat modified, according to the species to be dealt with; for while Dr. LeBaron found the tin and rope trap described last year so effectual with the Spring Canker-worm, it does not appear to afford any barrier to the Fall species, judging from the following notes, kindly furnished by Mr. Mann:

Nov. 8, 1873. Warm last night, with rain, which still continues. Found 25 ♀ and one ♂ *pometaria*. Found 4 of the ♀ above the LeBaron zinc band.

Nov. 9. Found 2 ♂, 37 ♀ *pometaria*; 2 ♀ above the zinc band.

Nov. 12. Snow last night, followed by cold sleet. Found 9 ♀ *pometaria*, 1 above the zinc.

Nov. 15. Only 6 ♀ *pometaria*; none above the band. Last three days freezing cold, but not stormy.

Nov. 18. Several days of rain and snow. 1 ♀ *pometaria*.

Nov. 22. 6 ♀, 2 ♂ *pometaria*.

Dec. 4. Yesterday thawing, to-day also. The weather since Nov. 22 has been cold, with occasional snow, and the ground has been frozen, and I have failed to find any *Anisopteryx pometaria*; but to-day I caught 11 ♂, 102 ♀, 2 ♀ above the zinc band. I have no doubt that the smallness of the number of ♀ found above the bands of zinc is due to my promptness and diligence in detecting and destroying them before they have had time to mount the tree; because, according to the theory on which the experiment was tried, the ♀ ought to be found on the outside of the strips, if their ascent has been prevented by them; while in fact, (excluding those found on the house or fence, etc.,) the majority of the ♀ have been caught before they reached the bands; further, because I tried the experiment with 3 or 4 ♀, and found that as soon as they reached the top of the band, they climbed over it, and began to ascend the tree. Being satisfied by this positive evidence, which would outweigh any amount of negative evidence from those who have *not seen it*, I put printers' ink on the outside of the zinc strips. (I found that the ink was more quickly chilled or dried by being on the zinc, so last Winter I pulled it off and inked paper bands applied closely to the trunk).

Dec. 5. Colder. 25 ♂, 71 ♀ *pometaria*. The greater proportion of the ♂ than formerly is explained by considering that most of them were stuck to the ink; whereas formerly they could hide away by day. It is to be noticed that although some imagos appeared before the frost, they only swarmed after it, justifying the farmers' saying that you must have a frost to bring the Canker-grubs out.

Moreover, it is quite important that the orchardist be able to distinguish these Canker-worms from a number of other looping worms which greatly resemble them, but which produce moths which are winged in both sexes. "For if he mistakes some other span-worm which produces winged females as well as winged males, for the genuine Canker-worm which is apterous in the female moth state, it becomes very obvious that all his efforts to try and prevent the ravages of the spurious Canker-worm by the most approved and well-tried methods, will not only fail most absolutely, but he will lose all faith in such remedies, and may perchance, if he is given to the use of the quill, vent his wrath and disappointment by sending to some one of the horticultural journals of the land, a pithy article 'based upon FACTS [?] and EXPERIENCE,' showing up the utter worthlessness of the Canker-worm remedies!

"It is from such lack of true knowledge that the City Fathers of Baltimore, Maryland, went to the useless expense of furnishing oil troughs for all their large elm trees which were being defoliated, under the delusive idea that the insect committing the ravage was the Canker-worm; whereas it turned out to be the larva of a little imported Beetle (*Galeruca calmariensis*, Fabr.), the female of which has ample wings, and can fly as readily as a bird from tree to tree."—[2nd Rep., p. 95.

I will now give more detailed comparative descriptions of these two insects in their different stages, those of the moths being but slightly altered from the original comparisons drawn up by Mr. Mann, to whom I am under obligations for specimens of *pometaria* in all stages, and for the use of his notes.

ANISOPTERYX VERNATA.	ANISOPTERYX POMETARIA.
	Egg.
Elliptic-ovoid, the shell of delicate texture and quite yielding; generally appearing shagreened or irregularly impressed; nacreous, and laid in irregular masses in secreted places.	Squarely docked at top, with a central puncture and a brown circle near the border; of firm texture, and laid side by side in regular rows and compact batches.
	Larva.
No prolegs on joint 8.	With a pair of short prolegs on joint 8.
Head distinctly mottled and spotted, the top pale, and two pale transverse lines in front.	Head very indistinctly spotted and dark on top.

Body with eight superior, narrow, pale, longitudinal lines barely discernible, the two lowermost much farther apart than the others.	Only six superior broad and very distinct pale lines, those each side equidistant.
Dorsum pale, with median black spots; subdorsal region dark; stigmatal region quite pale.	Dorsum dark, without ornament; subdorsal region pale; stigmatal region dark.
Piliferous spots quite visible and large on joint 11, where the pale lines generally enlarge into white spots immediately in front of them.	Piliferous spots subobsolete.
When newly hatched *dark* olive-green or brown, with black shiny head and cervical shield.	When newly hatched *pale* olive-green, with very pale head and cervical shield.

Chrysalis.

Same as *pometaria*, so far as known.	Stout, the female with wing-sheaths, and a small decurved horn, bifid at extremity near tip of abdomen, superiorly.

Imago.

The first seven joints of the abdomen of both sexes bear each upon the back two transverse rows of stiff, red spines, pointing toward the end of the body.	The first seven joints of the abdomen of both sexes with no spines upon the back.
Front wings of male, on upper surface ash-colored or brownish gray; the whitish spot found on the front wings of *A. pometaria* is wanting.	Front wings of male on upper surface ash-colored with a faint purplish reflection, and with a distinct whitish spot on the front edge near the tip.
The whitish bands found on the front wings of *A. pometaria* are wanting, but there is a jagged, subterminal white band in most specimens, running out to the apex, where it is lined externally with dark brown.	[Front wings] crossed by two jagged whitish bands; the outermost band has an angle near the front edge. The white bands are often entirely wanting, in which case only the whitish spot near the tip remains.
There are three interrupted, dusky lines across the front wings, instead of two pale lines, as in *A. pometaria*. Sometimes these lines are only indicated by dark spots on the costa and by blackish dashes on the median nervure; rarely are they very distinct throughout their whole extent.	Along the sides of the whitish bands there are several blackish dots, each on a nervure, and all generally connected together by a dusky band, which includes them, and runs on that side of each whitish band which is towards the other. These bands remain visible when the whitish bands are wanting.
There is an oblique, blackish dash near the tip of the front wings, crossing a nervure; and there is a distinctly interrupted, or nearly uniform, continuous line of blackish along the outer margin, close to the fringe.	Within the angle of the outermost whitish band, near the costa, there is a short, faint, blackish line, following a nervure; and there is a row of black dots along the outer margin, close to the fringe.
The hind wings are pale ash-colored, or very light gray, with a faint blackish dot near the middle.	The hind wings are pale ash-colored, or light gray, with a faint blackish dot near the middle.
The white band found on the hind wings of *A. pometaria* is wanting.	In most specimens a curved white band is plainly visible on the hind wings, about half way between the middle and the end

On the costa, opposite the beginning of the outermost dark band of the upper surface, and on the edge of the disk, are dusky spots on the lower surface of the wings. Along the median nervure beneath is a dark line. These marks are sometimes indistinct.	The outermost pale band of the front wings, with its angulation, and the band cf the hind wings are also visible on the under side of the wings. Within the angulation is a brown or blackish spot on the costa.
	Antennæ of male more serrate and hairy; the serrations darker.
Antennæ of female pubescent with the joints constricted in middle.	Antennæ of the female naked, with the joints only half as long as in *vernata*, and uniform in diameter.
Abdomen terminating in a retractile ovipositor; rather acutely tapering behind.	Abdomen not terminating in an ovipositor; rather bluntly tapering behind.
Whole body and legs of the female pubescent, clothed with whitish and brown or black dentate scales or hairs; general coloration not uniform. A black band along the middle of the back of the abdomen, often interrupted on the second to seventh joints; with a whitish patch each side of its front end; the spines frequently giving a reddish appearance to the part they occupy.	Whole body and legs of the female smooth, clothed with glistening brown and white truncate scales intermixed, giving it an appearance of uniform shiny dark ash-color above and gray beneath.
Crest of prothorax and mesothorax black.	
Of a rather smaller size than *pometaria*, the wings of the male expanding from 0.86—1.30 inches, and the female measuring 0.20—0.35 inch in length.	The wings of the male expand from 1.05–1.35 inches; and the female measures 0.25 to 0.40 inch.

CONCLUSION.

We thus have two distinct species of canker-worms, differing not only in habit, but differing so much structurally in all states (except, perhaps, the chrysalis state) that they may at once be distinguished from each other. In contrast with the soft delicate ovoid eggs secreted in irregular masses, the 10-legged larva, and the spined and hairy moths of *vernata;* we have the tough, flower-pot-shaped eggs, laid in exposed regular masses, the 12-legged larva and the spineless, smooth moths of *pometaria;* and the specific structural differences are still apparent when we come to examine the genital armature of the males. It is really remarkable that these differences have remained so long unnoticed, especially in those parts of the country where *pometaria* abounds. As a fitting conclusion to what I have written on this subject, it gives me pleasure to be able to reproduce, through the courtesy of Mr. Mann, who copied them for me, portions of the original premium essay on the Canker-worm, by Mr. Peck, not only because of the value and accuracy of the observations, but because they show so conclusively that it was the true or Spring species upon which the essay was based.

Extracts from the original Essay on the Canker-worm, by William Dandridge Peck, published in 1795.

To cultivate a knowledge of insects, merely for their splendid plumage or gorgeous colors, is indeed a contemptible employment; but to inquire into the purposes of their being and the part they are destined to perform in the economy of Nature, is to study the wisdom of that Omniscient Being whose mandates they execute with the greatest exactness. * * * *

These insects (the Canker-worm) appear in the Spring earlier than any other of the moth tribe—about the middle of March. Their rise, however, from the earth will be delayed or hastened according to the temperature of the atmosphere and state of the soil. They are found under a double form, the males being furnished with, and the females being destitute of, wings. This circumstance necessitates the females to ascend the tree by its trunk in order to deposit their eggs upon the branches. The males by their wings resort to them, and are found in the evenings hovering round the trees. In three or four days after they begin to rise, they are found sub-copula. This office is performed in eleven or twelve days after their first appearance. The males die and disappear. In thirteen days the females deposit their eggs. These they place in the crannies of the bark in the forks of small branches; and where there are spots of moss upon the smaller limbs they seem most fond of insinuating themselves into the cavities between its leaves. For this purpose the females are furnished with a tube through which the egg is passed, with which she investigates the appertures in the bark or moss, and ascertains their depth. * * * Each female lays at a medium an hundred eggs. The ultimate purpose of their being thus performed, they die.

The egg is elliptic, 1-30 of an inch in length, of a pearl color, with a yellowish cast. As the included animal advances in ripeness the egg assumes a brownish hue; in twenty days is of a lead color, and with a moderate magnifier the larva may be seen to move in the shell. On the twenty-first day the larva breaks from its prison, is one line in length, and furnished with ten feet—six anterior and four posterior. * * * They are commonly hatched about the time that the *red currant* is in blossom, and the apple-tree puts forth its tender leaves. * * *

On the twenty-sixth day from their quitting the egg they begin to cease from feeding and descend by the trunk of the tree; when arrived at its foot they with great labor penetrate the earth near it to different depths; and this appears to depend in part on the quality of the soil and in part on the vigor of the animal. In grass land they are found from one to four inches beneath the surface, and when the trees stand in plowed land, if the soil be loose, they penetrate to the depth of seven or eight. * * *

It has been observed above that they descend by the trunk of the tree; all which descend in this manner enter the earth near it. This is their natural and regular course, and hence the greatest number of them is found within a circle, whose radius extends four feet from the trunk. But some will always be found at a greater distance, according to the area which the tree covers; for if dislodged by wind or accident at the time when they are about to seek the earth, they cover themselves near the spot they fall on. In recurring to the structure of the female insect we see at once the reason why they are naturally confined to a small circle.

The larva or catterpillar is, when full grown, about nine lines long; the head pale, marked on each side with two transverse blackish stripes; the back ash-colored, marked lengthwise with small, interrupted dusky lines; the sides blackish, with a pale line along the length of the body; there are two white spots on the last segment of the body; the abdomen or underside is ash-colored. * * *

The chrysalis state comes on in twenty-four hours after the larva has penetrated the earth; and it appears that the insect is soon perfect, since a course of warm weather has been found to raise some of them from the earth in the month of November. While they are in chrysalis they are uninjured by frost. Their natural and regular time of rising is about the middle of March, but happens sometimes as early as the twelfth, and is sometimes retarded to the twenty-fourth, according to the warmth or coldness of the season. They continue to rise for a longer or shorter time, according to the greater or less depth at which they lie, and the extrication of the frost from the earth—commonly from twenty to thirty days. * * * Like others of the moth kind, they are active only in the night, and in the day time sit close to the bark of the tree, whose color is so similar to theirs that they are not seen without near inspection. * * *

The principal check provided by Nature, upon the too great increase of this insect is the *Ampelis garrulus* of Linnæus, called by Mr. Catesby, the Chatterer of Carolina, and in the Rev. Doctor Belknap's History of New Hampshire, Cherry-bird. This bird destroys great numbers of them while in the larva state. Another check is a disease which may be called *Deliquium*, and is probably occasioned by a fermentation of their food. In this disease the whole internal structure is dissolved into a liquid, and nothing is entire but the exterior cuticle, which breaks on being touched.

The Canker-worm is said to have been observed first in the Southern States, where it is probably a native. It is certain it must be spread by some means independent of itself, since the female, by the privation of wings, is forbidden to range.

It may have been introduced into New England by the importation of trees from the Southern States, on which the eggs were deposited; or disseminated in the larva state, in all populous parts of the United States, by falling from trees upon carriages and travelers passing under them.

This conjecture is rendered probable by its being found in all places which have intercourse with such parts as are infected with it, and by its being unknown in new settlements.

THE GRAPE PHYLLOXERA.

The following notes on this insect are intended to supplement the article in the Sixth Report, and should be read in connection with said article. It is my desire to give a record of observations and discoveries, in the matter of Phylloxera, with as little repetition of what has previously appeared in these reports, as is consistent with intelligibility.

COMPLETION OF ITS NATURAL HISTORY.

During the year the natural history of the species has been all but completed; as I predicted it would be, after Balbiani had paved the way by his remarkable biological studies of the European Oak Phylloxera, made a year ago. It turns out, as was expected, that the Grape Phylloxera agrees with its oak congener in producing wingless and mouthless males and females; and the problematic winged individuals, with short bodies and relatively long wings and members, which individuals were looked upon by myself and others as the possible males, must necessarily be abnormal females.* The sexual individuals have now been traced in the Oak and Grape species (*quercus* and *vastatrix*) in Europe by Balbiani; and I have traced them in three species (*Rileyi*, *vastatrix* and what is probably *caryæcaulis*) in this country.

The life-history of the Grape Phylloxera may be thus epitomized: It hibernates mostly as a young larva (Rep. 6, Fig. 5,) torpidly attached to the roots, and so deepened in color as generally to be of a dull brassy-brown, and, therefore, with difficulty perceived, as the roots are often of the same color. With the renewal of vine-growth in the Spring, this larva molts, rapidly increases in size, and soon commences laying eggs. These eggs in due time give birth to young, which soon become virginal, egg-laying mothers, like the first; and, like them, always remain wingless. Five or six generations of these parthenogenetic, egg-bearing, apterous mothers follow each other; when—about the middle of July, in this latitude—some of the individuals begin to acquire wings† These are all females, and, like the wingless mothers, they are parthenogenetic. Having issued from the ground, while in the pupa state, they rise in the air and spread to new vineyards, where they deliver themselves of their issue in the form of eggs‡ or egg-like bodies—usually two or three in number, and not

*Balbiani (*Comptes Rendus Ac. d. Sc.*, Paris, September 21, 1874,) after a careful examination of these individuals, says that they play no special physiological rôle in the phenomena of reproduction; but that they have all the characters of the normal winged females, with, however, the generative organs atrophied; and may, in part, be compared to the neuters among bees and ants.

† During this virginal reproduction a gradual reduction in vitality and prolificacy is observable from generation to generation. Around the first virginal mother the eggs may accumulate by the hundred; but they decrease in number in succeeding generations until the individuals which—whether winged or wingless—lay the sexual eggs, give birth in no instance, yet recorded, to more than eight. From the true female again, or at the end of the cycle, only a solitary egg is born.

‡ It has been a question whether the egg-like bodies from these winged females, or from the wingless mothers which produce them, can properly be called eggs, and M. Lichtenstein has proposed to call them pupæ, because they give birth, not to a larva but a perfect insect. The term "pupa" is, however, manifestly incorrect as applied to these bodies, because, when first laid, they are transparent with a homogeneous content; while the sexual individual develops within the covering very much as the embryonic larva develops within the egg. In fact we have here, not, as in *Hippobosca*, a larva hatching and nourished in the ♀ abdomen until full grown and contracting to a pupa before delivered; but an insect hatching and undergoing its entire development within the egg-covering after the egg is delivered. Thus while the covering might more properly be called a sac just before the male or female creeps out of it, it is more truly an egg when first delivered; and so it is best to call it.

exceeding eight—and then perish. These eggs are of two sizes, the larger about 0.02 inch long and the smaller about three-fifths of that length. In the course of a fortnight they produce the sexual individuals, the larger ones giving birth to females, the smaller to males. These sexual individuals are born for no other purpose than the reproduction of their kind, and are without means of flight, or of taking food, or excreting. They are quite active and couple readily; one male being capable, no doubt, of serving several females, as Balbiani found to be the case with the European *quercus*. The abdomen of the female, after impregnation, enlarges somewhat, and she is soon delivered of a solitary egg, which differs from the ordinary eggs of the parthenogenetic mother only in becoming somewhat darker. This impregnated egg gives birth to a young louse which becomes a virginal, egg-bearing, wingless mother, and thus recommences the cycle of the species' evolution. But one of the most important discoveries of Balbiani is that, during the latter part of the season, many of the wingless, hypogean mothers perform the very same function as the winged ones; *i. e.*, they lay a few eggs which are of two sizes, and which produce males and females, organized and constructed precisely as those born of the winged females, and, like them, producing the solitary impregnated egg. Thus, the interesting fact is established that even the winged form, is by no means essential to the perpetuation of the species; but that, if all such winged individuals were destroyed as fast as they issue from the ground, the species could still go on multiplying in a vineyard from year to year. We have, therefore, the spectacle of an underground insect possessing the power of continued existence, even when confined to its subterranean retreats. It spreads in the wingless state from vine to vine and from vineyard to vineyard, when these are adjacent, either through passages in the ground itself, or over the surface. At the same time it is able, in the winged condition, to migrate to much more distant points. The winged females, as before stated, begin to appear in July, and continue to issue from the ground until vine growth ceases in the Fall. Yet they are much more abundant in August than during any other month, and on certain days may be said to literally swarm. Every piece of root a few inches long, and having rootlets, taken from an infested vine at this season, will present a goodly proportion of pupæ; and an ordinary quart preserve jar, filled with such roots and tightly closed, will furnish daily, for two or three weeks, a dozen or more of the winged females, which gather on the sides of the jar toward the light. We may get some idea, from this fact, of the immense numbers that disperse through the air to new fields, from a single acre of infected vines, in the course of the late Summer and Fall months.

If to the above account we add that occasionally individuals abandon their normal underground habit, and form galls upon the leaves of certain varieties of grape-vine, we have, in a general way, the whole natural history of the species.

DIFFERENT FORMS PRESENTED BY THE SPECIES.

The differences in form and habit which the species presents will be best appreciated by recapitulating them in tabulated form :

1—The gall-inhabiting type (*gallicola*—Sixth Rep., Fig. 4,) forming galls on the leaves, and presenting :

a—The ordinary egg (*ibid*, Fig. 4, *c*,) with which the gall is crowded :

b—The ordinary larva (*ibid*, Fig. 4, *a*, *b*) :

c—The swollen, parthenogenetic mother, without tubercles (*ibid*, Fig. 4, *f*, *g*, *h*) :

2—The root-inhabiting type (*radicicola*, Sixth Rep., Fig. 5,) forming knots on the roots, and presenting :

aa—The ordinary egg, differing in nothing from *a*, except in its slightly larger average size :

bb—The ordinary larva, also differing in no respect from *b* :

d—The parthenogenetic, wingless mother, the analogue of *c*, but covered with tubercles (*ibid*, Fig. 5, *f*, *g*) :

e—The more oval form, destined to become winged (*ibid*, Fig. 5, *e*) :

f—The pupa, presenting two different appearances (*ibid*, Fig. 6, *e*, *f*, and Fig. 8, *a*) :

g—The winged, parthenogenetic female, also presenting two different appearances (*ibid*, Fig. 6, *g*, *h*, and Fig. 8, *b*) :

h—The sexual egg or sac deposited by *g*, being of two sizes, and giving birth to the true males and females :

i—The male :

j—The true female :

k—The solitary impregnated egg deposited by *j* :

bbb—The larva hatched from *k*, which, so far as known, does not differ from the ordinary larva, except in its greater prolificacy :

l—The hibernating larva (*ibid*, Fig. 5 *b*), which differs only from *b* in being rougher and darker.

Thus the insect is found in at least a dozen distinct forms, excluding the variation that some of these forms are subject to ; while, in addition to what we already know of its power to change its habit, I will add that Balbiani reports having succeeded, by gradually accustoming the species to new conditions, in making the progeny of the root-louse live above ground, where, singularly enough, they did not form galls, but dwelt on the under side of the leaves like the Oak species. This change of habit was brought about after the third generation; and while it may probably never occur in nature, and finds its parallel in the well known instances of rearing several generations on a thick piece of root in tubes and bottles, yet it forcibly illustrates the power of adaptation and change which the species possesses. It may be also stated in this connection, that Dr. L. Rössler, of Klosterneuburg, Austria, has found the insect, of all sizes, above ground, under the loose bark near the base of the vine—a position which is quite exceptional for it to assume.

SPECIFIC IDENTITY OF THE GALL-INHABITING AND LEAF-INHABITING TYPES.

The reader of these reports will scarcely need to be told that the two types above mentioned are identical; but as the fact has been called in question by a few of our prominent grape-growers, I repeat here what I wrote on the subject not long since for the New York *Tribune :*

In the October number of the monthly report from the Department of Agriculture at Washington, there is the record of an experiment by Townend Glover, Entomologist to the Department, the object of which is, in Mr. Glover's language, "to prove the identity of the Pemphygus [Pemphigus] vitifoliæ or leaf-gall-louse, of Fitch, with the Phylloxera vastatrix, or root-gall-louse,* so injurious at present to the vineyards in France, and in parts of this country also." This is the experiment referred to in the *Tribune* of the first week of March last, and the item detailing it, shows, as I had anticipated, that no galls were produced. It also shows that "we cannot give the names of the vines [experimented with] as accidentally the labels were thrown away by the laborer when he removed the dead vines," and, though closing with a confession that the experiment decides little or nothing, it nevertheless appears to strengthen the belief held by many, that the leaf louse and root-louse are not specifically identical.

The item has been very generally copied in our agricultural papers, and has been widely disseminated over the country, through the monthly report, in which it first appeared. The average editor and the average reader of our agricultural and horticultural journals have not, nor can they be expected to have, nor do they pretend to have, profound knowledge in every specialty; and for these reasons items of this kind, coming from the fountain head, have a great in-

* This term, which is original with Mr. Glover, should be discountenanced, as the term "gall," strictly speaking, applies only to abnormal vegetable growths, caused by insects dwelling within them; and not to mere swellings induced by insects which always live exposed.

fluence in shaping popular opinion. It is all the more necessary, therefore, that information coming from such a source be trustworthy.

The ostensible object of the experiment described, was to prove the identity of the Phylloxera which forms galls on the leaves of the Grape-vine, with that which causes the swelling and rotting of the roots of the same plant. The inference from the attempt is, that the two forms had not so far been proved specifically identical. Yet the question had long since been settled by eminent observers, whose care and thoroughness have won for them respect and authority. Already in 1868, that eminent entomologist, J. O. Westwood, of England, who examined both types, announced that he could not perceive in them specific difference, and in the Fall of 1870, the specific identity of the two types was proved by myself, by obtaining root-lice (*radicicola*) direct from gall-lice (*gallicola*), and by showing that the young of the latter as they are carried to the ground by the fall of the leaf, creep on to the roots to hibernate, and there assume the characters of the root-inhabiting type. But anterior to my own experiments, the specific identity of the two types was thoroughly proved by three different and independent observers in France, and their observations are on record in different numbers of the *Messager du Midi*. Since then the identity of the two types has been confirmed in the most conclusive and emphatic manner by several observers, Maxime Cornu, more especially, having recorded in detail, in the *Comptes Rendus* of the Paris Academy of Science, his thorough and painstaking experiments, in which he not only institutes the most careful and anatomical comparisons, but records having actually watched the process of change from the one to the other. These articles, though originally appearing in the *Comptes Rendus*, have been copied in more popular works, while the facts have been recorded in this country. Finally, the specific inter-relation of the two types was still more firmly established last Winter by the production of an abortive gall from a root-louse.*

Indeed, the question has for some time been considered definitely settled by all who are well informed on the subject. Yet while further proof of the identity of the two types was scarcely necessary, all endeavors by experiment to obtain gall-lice from root-lice are praiseworthy and interesting, if they are carefully made. But the value of experiments like those made at Washington, where no intelligent choice is made of the particular varieties of vine employed, and where not even the names of the varieties are known, will appear from the following facts, which are well understood by all who have kept an

* See Sixth Mo. Rep., p. 41.

courant of the Phylloxera question: The gall-inhabiting type of the Grape Phylloxera is but a dimorphic, agamous and apterous female form, never becoming winged, never producing any males, and not at all necessary to the perpetuation of the species. It can only flourish on a few varieties of vine, and on the others it makes abortive attempts or no attempts at all to found galls. In short, there are but few among the many cultivated varieties of the Grape-vine upon the leaves of which the Grape Phylloxera—under conditions which we shall probably never understand—can form galls; while on the large majority of our varieties, such as Norton's, Catawba, Gœthe, Diana, Cunningham, Iona, Isabella, Martha, Maxatawney, Ives, North Carolina, etc., we may justly conclude that the insect cannot form galls, since galls are never found upon them. The attempt, therefore, to make the insect produce galls upon such vines must necessarily prove futile, and in the light of present knowledge, the first requisite in any experiment having such object, should be an intelligent choice of varieties.

Even where those vines are employed—as Clinton and varieties of *Riparia* and *Cordifolia*—upon which galls can be most readily produced, the experiment of producing galls upon them from root lice, will not be likely to succeed, and the failure to thus produce galls must count for little or nothing against the results already obtained.

The gall-louse is but a transient form, by no means essential to the existence of the species, and its existence depends not alone on the nature of the vine, but, as already stated, on other yet unknown conditions, which cause it to be abundant on a vine one year and perhaps entirely absent the year following. Now, these conditions may not obtain in one out of a hundred experiments, and the number of fruitless efforts properly and intelligently made to obtain these galls, both in Europe and this country, attest the difficulty here encountered. I have even found the greatest difficulty in producing galls from the progeny of the gall insects themselves, in my experiments in-doors.

Loose experiments, especially when, as in this instance, they convey wrong impressions, do more harm than good. I hope, therefore, that the facts here stated will serve to offset the article in the Department Reports.

WHERE DO THE WINGED FEMALES LAY THEIR EGGS?

Last Fall I was not a little surprised by a letter from my friend Lichtenstein, of Montpellier, France, under date of September 6th, announcing the fact that he had just discovered that the winged Grape Phylloxeræ congregate in immense numbers on the leaves of the Chermes Oak (*Quercus coccifera*), a small shrubby tree growing on the higher lands of that country: further, that they make a nidus of this tree, to the leaves of which they consign the few eggs in their abdomen. Notwithstanding my high appreciation of his knowledge regarding the different species of Phylloxera, I immediately wrote to my friend that he must be wrong, as we have no Chermes Oak in America, and I had never found the winged Grape Phylloxera upon any of our oaks, though I had frequently beaten it in August from vines. From an examination of specimens which accompanied the letter, I suggested that he had mistaken the European Oak species (*quercus* Fonsc.) for the Grape species (*vastatrix*). Subsequent careful studies by Balbiani and others, proved this suggestion to be correct. Yet M. Lichtenstein still believes that he not only found the winged females of two species that infest the Oak there, but that among them there were some of the Grape-vine species. In that event, the following conclusions are inevitable: 1st, as the Chermes Oak does not occur here, the winged Grape Phylloxera in America, and in all countries outside the range of that oak, must make a nidus of some other tree; 2d, the young (progeny of the sexual individuals) brought forth on such trees when they are far away from vineyards, must inevitably perish; because they are not winged, and have feeble power of locomotion. From the fact that I have beaten from our Post Oak, a large winged Phylloxera answering to the description of *Ph. caryœcaulis* Fitch, which makes a large, irregular, smooth gall on the leaf-stalk of the Bitternut Hickory, and which certainly does not inhabit oak trees, I am the more disposed to believe that chance individuals of the Grape species may also be found on oaks,* and am thus forced to the following conclusions: The winged females of Phylloxera (and the same will hold true of two allied genera—*Pemphigus* and *Eriosoma*) are not drawn by instinct to any particular plant, but are wafted about and will lay their eggs, or, in other words, deliver themselves of their issue, wherever they happen to settle. If this is upon their proper food-plant, well and good; the young live and propagate: if not, they perish. We should thus have the spectacle of the species wasting itself to a greater or

* This hap-hazard, wandering habit is well known to belong to several closely allied Aphidians, and the winged female of *Pemphigus vagabundus* Walsh, which forms a large coxcomb-like gall on the Cottonwood, and can breed on no other tree, is often found in the Fall of the year so abundantly on all kinds of trees and shrubs—as every entomologist in the habit of "beating" is aware—that it was named in consequence of this wandering habit. I have reason to believe that in *Pemphigus* as in *Phylloxera,* the winged females give birth in the Autumn, after leaving their galls, to wingless sexual individuals whose issue must naturally perish on all trees except Cottonwoods.

less extent, just as most plants annually produce a superabundance of seed, the larger proportion of which is destined to perish. From a large number of facts that have come to my knowledge in insect-life I actually believe this to be the case; and, if so, it adds one more weighty reason to those I have already given why the insect is so injurious in France, and explains its rapid multiplication in the thickly planted vine districts of that country. There, few winged insects would fail to settle where their issue could survive; while in our country there must be, on this hypothesis, an immense number annually perishing in the large tracts of other vegetation between our scattering vineyards.

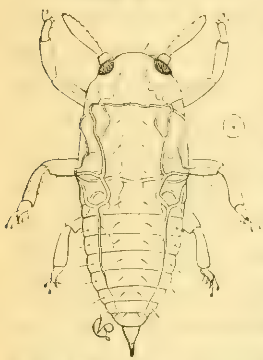
The particular part of the vine chosen by these winged mothers, when they settle in a vineyard, for the deposition of their eggs, has not yet been definitely ascertained. "In confinement I have had such eggs deposited both on the leaves and on the buds, and from the preference which, in ovipositing, these aerial mothers showed for little balls of cotton placed in the corners of their cages, I infer that the more tomentose portions of the vine, such as the bud, or the base of a leaf-stem, furnish the most appropriate and desirable *nidi*. On this hypothesis it is quite possible for the insect to be introduced from vineyard to vineyard, or from country to country, as well upon cuttings as upon roots."—[6th Rep. p. 46. So I wrote a year ago; but while these eggs may frequently be laid upon the vine itself, I am now disposed to believe that they are more often laid in the minute cracks and interstices on the surface of the ground, especially near the base of the vine; for where I have had the females confined in tubes or bottles half filled with moist earth, they have often deposited in the interstices at the sides of the vessel, and, as Balbiani has remarked, the constant elongation of the abdomen, and tentative motion of the tip from side to side, which is common to these winged mothers, rather indicate search for some such positions.

THE SEXUAL INDIVIDUALS.

We have seen that the winged females abound, especially during August, and that they deliver themselves freely of their egg-like contents. They are quite active during the warmer parts of the day and are comparatively short-lived, at least in confinement, where they usually die along side their eggs. These eggs are twice as long as wide, the larger ones, which produce females, about 0.025 inch and the smaller 0.018 inch long. They are quite pale and translucent and soon begin to show the reddish eyes of the embryon within. They hatch, however, with great difficulty in confinement; and though I have had several hundreds under my care at one and the same time, in tubes and in jars, with and without moist earth, yet I have succeeded in getting but two females to hatch; though many of them if mounted in balsam before life departs and they become discolored, will show the characters of the enclosed animal with tolerable distinctness. Balbiani found the same difficulty in hatching these sexual eggs from the winged females; but had better luck with those from the wingless underground individuals, which seemed to hatch more readily.

These sexual individuals are, as already stated, entirely destitute of mouth-parts, and have simply, in their stead, a little tubercle where the proboscis of the other individuals originates. The male is readily distinguished by the penis which extends from the tip of the abdomen, and is bulbous at base, but terminates in a sharp point. The female is distinguished by the pedunculated third joint of her antennæ, but except in these striking characters, they bear a close resemblance to the ordinary larva. I introduce in illustration of the male, a dorsal figure of the male of a larger species (probably *caryæcaulis* Fitch*) the mounted specimen of which is a better subject to figure than those from *vastatrix;* and in connection with the ventral view given further on of the male of the American Oak Phylloxera, will convey a sufficiently exact impression.

[Fig. 19.]



MALE PHYLLOXERA: the dot within circle showing natural size.

INJURY DONE DURING THE YEAR IN AMERICA.

The Phylloxera was less numerous and did less injury in 1874 than in any of the three previous years. This was owing principally to the fact that there was a good deal of wet weather in the Spring, though it was unusually dry in most parts of the State later in the season. The grape crop was unusually good, the character of the wine also superior. Yet, notwithstanding the excellence of the average crop of the

* This was obtained from some large winged females, beaten, the latter part of September, from some small Post Oaks. From a comparison with the described N. A. species, I take it to be the *Ph. caryæcaulis* Fitch, which forms galls on the petiole of the leaf of the *Carya glabra* (see Synopsis, further on). The winged ♀ is more than twice as large as *vastatrix,* with much blacker mesothoracic band, duskier shades on the head, and duskier wings and members. The male is quite pale in color, 0.02 inch long, with the claws and digituli rather small; but agreeing very closely in structure with the male of *Rileyi,* except in the conspicuousness of the nerves which show through the transparent skin in the manner indicated in the figure,

State—notwithstanding the fact that the Catawba and many other of the more susceptible vines did better than usual; the injury from Phylloxera was often quite apparent in the Fall, and I know of a four-year old Gœthe vineyard in St. Louis county which gave great promise a year ago but which had about succumbed in September; half the vines being at the point of death, and most of them showing the acute symptoms, with the finer roots all wasted away and the larger ones covered with the lice, as completely as is usual with European vines. Such facts serve to show that the insect is by no means destroyed even where, as in 1874, it is with difficulty found in early Spring. Here, therefore, let me reiterate, what cannot too often be repeated, that while only very careful search will detect the insect at the awakening of Spring, and its presence is best indicated by the swollen and rotting roots wherever it has been at work; yet it multiplies so rapidly that in midsummer and Autumn a casual examination will generally reveal it in great numbers on infested vines. I wish to impress this fact for the simple reason that in several instances where correspondents reported no trace of Phylloxera on their vines last Spring, I subsequently showed them abundant evidence of its presence, evidence which at once dispelled their skepticism. While my observations were confined for the most part to our own State, and more especially to St. Louis county, the following valuable letter of experience will show that intelligent grape-growers are recognizing its work in other States:

MY DEAR SIR: I beg you will pardon my tardy acknowledgment of your polite attention in sending me your very interesting, and, I may say, almost exhaustive report upon the Grape Phylloxera. Although I have been, in a casual way, observing the leaf-infesting form of this Aphid since 1861, I find much that is new to me in your paper; but I am obliged to say, so far as my observations have extended, that they accord almost identically with yours. I did not then even suspect the presence of the root-louse; not indeed until I had seen some account of your investigations. * * * From the increase of its insect-enemies, or from some other cause, the gall-louse has entirely disappeared from this section, and vines formerly infested are now wholly exempt. I wish I could say as much for the root-louse. I hardly think the latter increasing, but he certainly seems to "hold his own." I have one vine, a seedling from Concord, which I call "Lady," a white variety, which, so far, has been entirely exempt from its attacks. From its parentage, I should expect it successfully to resist serious injury, but not to enjoy exemption. Either from some native hardiness, or because it is not entirely to its taste, I have found Concord not injured much even when infested, and only the small, fibrous roots attacked. To a considerable extent, Hartford, Ives, Telegraph, and this class of vines seem able to resist and overcome the attacks of the root-louse, when the various kinds known as "hybrids" succumb, as well as Iona, Catawba, and others of that class. I am well satisfied this root-louse is the most serious of all the enemies the grape-grower has to contend with, and I believe it has been the cause of many failures which seemed unaccountable. As a matter of curiosity, I will send you copy of a letter to the *N. Y. Tribune* in 1863.

Truly yours,
GEO. W. CAMPBELL.

DELAWARE, OHIO, December 23, 1874.

The letter to the *N. Y. Tribune*, referred to by Mr. Campbell, and written in 1863, gives an interesting account of the gall-inhabiting type, and its effect on the leaves.

In addition to the foregoing in illustration of the insect's injuries in America even during a most favorable year for vine growth, our horticultural literature has given further evidence of the same character. Mr. F. R. Elliott, for instance, one of our most prominent horticultural writers, and ex-Secretary of the American Pomological Society, has had much to say during the year about the acknowledged feebleness and failure of many varieties, and among them the Eumelan, Wilder, Catawba and Isabella. But he attributes the trouble to injudicious methods of propagation, and lays the blame to the door of the nurserymen, who, he asserts, in their avidity for gain, have sent out wood that was immature and lacked vitality. His ideas have been very generally, and, I think, successfully repudiated; and, in fact, his argument ought to apply to all varieties—those which succeed as well as those which fail; and while in some few instances there may be foundation for them, I cannot help thinking that the work of Phylloxera has had much more to do with the general feebleness and failure of such varieties.

It must not be forgotten that the character of the soil has very much to do in furthering or impeding the injury from Phylloxera, and that the successful growth of susceptible varieties—as of the Delaware around Warrensburg—may often be accounted for by the sandy nature of the soil; for the insect cannot multiply in such a soil, to the extent it can in one less yielding and more apt to form fissures, crevices and passage-ways.*

RANGE OF THE INSECT IN AMERICA.

Under this head, after showing that the insect is indigenous to the United States east of the Rocky Mountains, I wrote, last year, as follows: "I have myself found it in Kansas, Iowa, Illinois, Missouri, Michigan, Ontario, New York, New Jersey, Pennsylvania and Maryland, and have good evidence of its occurrence in Connecticut, District of Columbia, North Carolina, Texas, and as far south as Florida. It doubtless occurs in all the intermediate States." Its occurrence in Connecticut can now be affirmed; for I found it around Hartford, and upon being informed by Mr. H. T. Bassett, of Waterbury, that he had certain vines which were sickly, I repaired thither with him, and the very first roots obtained revealed the enemy and its work. Yet

* As bearing on this point, in addition to what I have said in previous years, Mr. Chas. Teubner, of Hermann, who, in a communication read at the last annual meeting of our State Horticultural Society, reports most grapes as doing well, and insects less injurious than usual, remarks that "in locations where the soil was sandy, grapes did best in every respect, and it is my opinion that to use sand freely in a vineyard (where it can be got) will materially aid in diminishing disease, and bringing the vines into a flourishing condition."

it certainty does not occur in many parts of Georgia and South Carolina, as is plainly indicated by the following letters which I give entire, because they show how thorough were the observations, and describe the character of the soils in which said observations were made. Yet I have such faith in the general distribution of the insect in the country east of the Rocky Mountains that I fully expect that it will yet be found even in Georgia and South Carolina; and I half suspect that the failure of Messrs. Ravenel and Berckmans to find it, is owing perhaps more to an exceptional season, unfavorable to its development, than to its non-existence there. However, suspecting is not knowing, and here are the facts, as they are given:

Dear Sir: I am in receipt of yours of 25th inst., requesting me to give you the result of my various examinations for Phylloxera.

Having been appointed by the American Pomological Society at the Boston meeting last year, one of a committee to examine and report in regard to the matter, I have made this season as careful and comprehensive an examination as I could well do. What I had to say on the subject has been already sent on to one of the committee to be embodied in the report. As it consists simply of the results of my examination, a statement of the facts which came under my observation, I will very cheerfully repeat them here. I confess to a surprise at not finding a Phylloxera, but yet I feel perfectly satisfied that my examinations were as careful and thorough as it was possible. I offer no opinion, but give simply a statement of facts taken from my notes made at the time.

June 15, 1874—Examined to-day 4 Isabella and 1 Black July vine, and also 1 Warren, (Herbemont,) in my garden; all old vines. I could find no trace of insect life, neither eggs nor young lice upon the young rootlets, nor the effects of former ravages on the older roots.

June 17, 1874—Examined the following in vineyard of Rev. T. H. Cornish, and with his assistance, viz.: 5 Chasselas de Fontainbleaux, 1 Muscat of Alexandria, 2 Catawba, 1 Pauline and 1 Isabella.

These vines are from twelve to fifteen years old, generally quite healthy and the fruit, up to a few days ago, free of rot; now more rot on the Warren. No trace of insect life on the young, or on older roots, or on any of them.

July 24, 1874—Examined 2 Isabella and 1 Warren in my own garden; and in Mr. Cornish's vineyard, 1 Chasselas, 1 Muscat of Alexandria, 1 Catawba and 3 Warren. Found nothing.

Aug. 22, 1874—Examined 2 Isabellas in my own garden; found nothing.

Sept. 9, 1874—Went over to Mr. Berckmans' *Fruitland Nursery*, near Augusta, Georgia, and made an examination of vines in various parts of his grounds, of several different varieties and under different modes of cultivation. I had the benefit of Mr. de Hardy's assistance in all my examinations, as he had seen the Phylloxera in France and was familiar with its appearance, and the effects of its ravages. In each case the whole vine was dug up carefully and the roots subjected to a close and scrutinizing examination. We found no trace whatever of the insects, nor the effect of any ravages in previous years upon the older roots. We took specimens from 7 different vineyards, some under cultivation and others thrown out for a year or two.

1 Israella, 7 years old, uncultivated for one year.
1 Clinton, 12 years old, uncultivated for one year.
1 Clinton, 3 years old, under cultivation.
1 Catawba, 15 years old, out of cultivation two years.
1 Golden Clinton, 4 years old,
1 Concord, 3 years old,
1 Wilder, 3 years old, } Under cultivation.
1 Northern Muscatine, 3 years old,
1 White Riesling, 3 years old,
1 Taylor, 4 years old, cultivated.
1 Alvey, 6 years old, uncultivated for one year.

The above is simply a transcript from my notes, and is at your disposal. I feel satisfied that had the Phylloxera been present, it could not have escaped my observations, and I can safely say, that it was *not infesting* the vines which came under my examination.

Very truly yours, H. W. RAVENEL.

AIKEN, S. C., November 30, 1874.

In yours of the 5th inst., received yesterday, you inquire about the character of the soils in which I examined grape vines. There were three localities:

First. My own lot in Aiken, into which I moved a year ago, and found there vines growing. This is a light (extremely light) sandy soil, clay from eight to ten feet beneath. We are just on the border of the "Sandhill" region, a belt of four sand hills, running about 100 miles parallel with the sea coast, about ten to fifteen miles wide, and extending from North Carolina, through South Carolina into Georgia.

Second. Rev. Mr. Cornish's vineyard has more clay, but could not be called a clay soil, perhaps only a good admixture.

Third. Berckmans' "Fruitland," four miles west of Augusta, is a red, or rather brownish soil, with just clay enough to make a freable loam, made darker of course by manurings, and containing a vast quantity of rounded pebbles, intermixed, from one to two or three inches in diameter. I think that these three soils represent the soils most commonly in cultivation. * * *

Yours, cordially, H. W. RAVENEL.

AIKEN, S. C., December 11, 1874.

DEAR SIR: I am glad Mr. Ravenel gave you a detailed account of his observations. Last September he spent some days with me, and we visited several localities, and carefully investigated many vines from 1 to 15 years old. Since then I have examined vines in Atlanta, some 15 varieties, Æstivales and Labruscas, but no signs of Phylloxera. Soil there quite compact; a clayey loam. On my place the soil is of mixed character. The whole tract is underlaid with a red clay subsoil, except in my low lands, which are alluvial. A portion, 300 acres, is what is termed here "Mulatto land," a rich loam of about 18 to 24 inches deep. Another portion is mixed with gravel and red clay subsoil, and a small portion is more sandy. All my land is what is called here red land, in contradistinction to the sandy region, which is called grey land. One mile from my house is a creek. On my side the subsoil is red clay; on the opposite it is white clay and sand, and a little higher up on the ridge no clay whatever is found, even to a depth of 200 feet, as was shown where a well was sunk of that depth. In making our observations last Summer in every variety of soil of this region, I have kept a memorandum of each variety examined, and the class of soil wherein it was planted. From your statements I anticipated fully to find the insect, but so far I am safe in saying that your predictions as to our section being infected with the Phylloxera is, happily for us, not fulfilled so far.

Yours truly,
P. J. BERCKMANS.

AUGUSTA, GA., Dec. 10, 1874.

Regarding its introduction into California around Sonoma, Mr. G. L. Wratten wrote, under date of July 9, 1874, that he is quite sure they have it, but that the grape-growers there are quite excited about the matter, and wish to hush the fact.

INJURY DONE DURING THE YEAR IN FRANCE.

So much of the wealth and prosperity of France depends on her grape crop, and the result of the grape harvest is looked forward to with so much anxiety, that the Phylloxera continues to occupy the lively attention of that nation. The investigators have been active and numerous, and each week this little insect occupies no inconsiderable portion of the time of the French Academy. The government has increased the amount of the reward for a simple, available remedy, from sixty thousand to three hundred thousand francs; while several societies have offered minor sums for the same purpose, and to enable the proper experiments and observations to be carried on.

The decrease which the Phylloxera had caused in the grape product for the past few years has, however, been made up by an excellent average yield in 1874. Notwithstanding injurious late frosts, a severe hail storm and the Phylloxera in some of the southern departments, the yield in the country at large, both in quantity and quality, has been above the average, and her 2,000,000 hectares (nearly five million acres) of vines, giving employment to 7,000,000 laborers, produced, according to the *Economiste Francais,* as much as 70,000,000 hectolitres (over 1,850,000,000 gallons) of wine. Indeed, the vintage was so unusually good in the non-infested districts, that there was an insufficiency of casks; while in some of the ravaged districts it was so poor that the wine makers were glad to sell their casks, for which they had no use, to their more fortunate countrymen.

M. L. Bazille, of Montpellier, in a recent letter says:

> The Phylloxera continues to commit great ravages in our vineyards. We are on the eve of losing them entirely. Those who can submerge do so and with success. They are convinced of its beneficial effects. The efforts and sacrifices made to organize and employ this method attest its value. Several persons have built large engines to elevate the water, and others have been at very large expense to obtain and control water. But it is only the few who can afford such outlays, and the mass of our grape-growers, in view of the poor success attending other remedies, fall back on the use of American vines, through which they hope to be relieved of embarrassment.

SPREAD OF PHYLLOXERA IN EUROPE.

It would be out of place in this report to give a detailed account of the spread of the insect in Europe, and it suffices to say that it continues to widen its territory in France, and that several neighboring European governments have taken stringent measures to prevent the importation of vines from the infested districts of Europe and from America. Just as its presence at Klosterneuburg, near Vienna, Austria, discovered in 1872, was easily traced to American vines which had been introduced there; or as its appearance in Portugal during the same year was referable to the same cause; so at each new point where it has been discovered, its presence has been easily explained, either by gradual spreading from infested districts or by importation on infested vines. Thus its discovery during the year at Pregny, near Geneva, Switzerland, seemed at first to baffle explanation. The fatalists contended that it must have passed from Lyons, France—the nearest infested region—and declared that it was useless to contend against an enemy which could pass over a hundred miles in a season. M. Dumas, perpetual Secretary of the French Academy, conceiving the importance of having the problem studied and elucidated, commissioned Max. Cornu to make the proper investigations, the result of which was to prove that the only way in which the insect passed the Jura and reached Pregny without leaving its tracks on the way, was by rail, and carefully packed in boxes. In fact it was traced to a grapery belonging to Baron Rothschild, in which were cultivated a number of varieties, and, among others, some obtained from an English grapery, and received as young plants in pots. The insect has for many years existed in graperies in England and Ireland, and the particular vines in question were found to be badly infested. All the infested vines have been condemned to destruction by the Swiss Government.

The insect has, also, recently been found in small quantities on American vines at Bonn, in Prussia, and the German Government has prohibited the importation of American vines.*

DIRECT REMEDIES.

There is little to add to what was said on this subject in my last report. Very elaborate experiments have been carried on in France and as elaborately recorded; yet the fact remains that, as we have already seen, submersion, from the practical standpoint, is the only remedy which is being extensively employed. The use of sand, especially when mixed with cinders and guano is highly spoken of, and the methods of invigorating the vine by fertilizers rich in potassic salts continue to gain in favor. M. Mouillefert, who has experimented at Cognac with sulpho-carbonate of potassium—generating and conveying it in different ways—and M. Balbiani, who has persevered at Montpellier in the use of coal tar, have proved that both these substances may be employed with good effect to destroy the Phylloxera; but it remains to be seen whether their methods will fulfill the requirements by coming into general use. The sulpho-carbonate, which was employed at the suggestion of M. Dumas, is placed at the rate of four ounces in a hole at the foot of a vine. By decomposition the sulphuret of carbon, spoken of last year, is generated and kills the lice without

* Since this was written, I have received the following note from Dr. G. Blankenhorn, of Carlsruhe, referring to the discovery of the insect in other localities:

Your excellent work on the Phylloxera I have copied in my "Annalen der Œnologie," and it has done much to help us in Germany to understand this insect. The subject grows more and more important for us Germans since our viticulture is threatened. You probably have already read that it has been discovered during the last few weeks in three different localities in Germany, (in Annaberg, by Kornike and Kreusler; in Carlsruhe, by myself and D. Moritz, and in Worms), and without exception only upon American grape-vines."

affecting the vine. The instrument used for introducing the liquids intended to generate the destructive gases, is an augur with a hollow shank, perforated just above the cutting portions. The liquid is poured into the hollow portion of the augur from above the handles.

NATURAL ENEMIES.

It appears pretty certain that the mite I described last year as preying on Phylloxera, is likewise found in Europe; or at least a species that cannot well be distinguished from it. Thus during the year, M. A. Fumouze, an authority on these minute animals, has published some notes showing that he has found this same Tyroglyph on roots affected with Phylloxera in France, and that it is apparently the *T. echinopus* described by himself and Ch. Robin in the *Journal de l' Anatomie et de la Physiologie*, in 1868. Prof. L. Rœsler, of Klosterneuburg, Austria, also announced to me by letter that he has found and studied both the Phylloxera Mite and the Mussel-shaped Mite (*Hoplophora arctata*) on the infested vines of that place. He has also observed, in addition, the larva of a Lace-wing (*Chrysopa*) and the Myriapodous *Pollyxerus cagurus* preying on Phylloxera underground.

In addition to the Weeping Lace-wing mentioned last year, I have this year reared the Consumptive Lace-wing (*Chrysopa tabida* Fitch) from larvæ preying on the gall-lice.

In reference to the heteramorphism of these mites M. Méguin states* that *Hypopus*, *Homopus* and *Trichodactylus* are but heteromorphous pupæ of different species of Sarcoptides, and among them of *Tyroglyphus*. He proves that, as Claparède observed in the aquatic *Atax*, a new individual is formed under each skin, and all the parts are developed anew, and not simply drawn out of their old envelopes, as was formerly supposed.

SUSCEPTIBILITY OF DIFFERENT VARIETIES.

In addition to that already published under this head, I have simply to add that M. Eugene Morel, of Ridgeway, N. C., sent me last August leaves of the Scuppernoug (*Vulpina*) covered with the Phylloxera galls, so that this species can no longer be considered exempt from the attacks of the gall-making type, though the more injurious root-inhabiting type has not yet been found upon it. The "Telegraph" should be taken from the list of Summer grapes (*æstivalis*) and placed with the Northern Fox (*Labrusca*); and the Delaware

* *Comptes Rendus de l' Ac. des Sc.*, Paris June 8, 1878.

should be removed from *Riparia*, also to Labrusca. Though the exact position of the Delaware in the classification of the genus *Vitis* has been a mooted question, and some have even supposed it had a European origin; yet those who have most studied the subject now concur in the opinion, years ago expressed by Fuller in his *Grape Culturist*, that it belongs to *Labrusca*—an opinion substantiated by the facts that its seedlings almost invariably show true, undoubted Labruscan characters, and that other undoubted varieties of Labrusca (as Shepherd's Delaware, raised from seed of Catawba) bear a similar pale fruit and delicate leaf, and otherwise very closely resemble it. The seed characters bear out this opinion, though they also indicate that the variety may contain a slight strain of the European *vinifera*. It is not improbable, therefore, that the Delaware owes its characters to hybridization, by insect agency, between *Labrusca* and *vinifera* (the Labrusca strain predominating), and this view would be greatly strengthened if it could be proved—as was doubtless the case—that European vines were cultivated at Frenchtown, N. J., where Mr. Prevost first found the Delaware. This origin and nature of the Delaware, by the way, throws a flood of light on its susceptibility to Phylloxera.

The nature of the "Jaques," which successfully resists Phylloxera in the vineyards of Mr. Laliman at Bordeaux, in France, and of which I have stated (Fifth Rep. p. 66,) "I do not know this variety unless it be a synonym of the Ohio," has been fully discussed by Prof. Planchon,* and by Mr. Bush in his new Descriptive Catalouge.† I reproduce what is said of it in this last little work, which is a most valuable manual, and reflects great credit on the firm that issues it. From this extract it will be seen that Mr. Bush is strongly inclined to the opinion that the vine so prized in France, under the name of Jacques, is in reality the Lenoir.

OHIO. Syn. SEGAR-BOX, LONGWORTH'S OHIO, BLACK-SPANISH ALABAMA; is now understood to be identical with the "Jaques" or "Jack," introduced and cultivated near Natchez, Mississippi, by an old Spaniard of the name of Jaques. It used to be grown in Ohio, where the stock originated from a few cuttings left in a segar box, by some unknown person, at the residence of Mr. Longworth, of Cincinnati, Ohio. * * *. Downing (Fruit and F. trees of Am.) said "it is most likely a foreign sort, and except in a few localities, a *sandy soil* and a mild climate, it is not likely to succeed." But Geo. W. Campbell, whom we have to thank for valuable information on this and many other varieties, says: "I always considered the Ohio or Segar-Box, from its fruit, habit of growth and foliage, as of the same family as Herbemont, *Lenoir*, Elsinburgh, and that class of small, black, southern grapes." * * *. A few vines sent years ago, under the names of "Jaques" or "Ohio," to France, by P. J. Berckmans, of Georgia, proved very fine and valuable, perfectly resisting Phylloxera, having remained healthy in the midst of vineyards destroyed by the root louse. This attracted great attention

* *Les Vignes Americaines; leur Culture; leur Résistance au Phylloxera*, Paris, 1875.

† Bushberg Illustrated Catalogue, 1875.

and gave importance to this variety. But when Mr. Berckmans was asked for more of these vines, he stated that he had none, and that their culture had been entirely abandoned. The above descriptions by our most experienced and reliable horticulturists, make it more than doubtful whether the vines, succeeding so well in the vineyards of Mr. Borty, at Roquemare, and of Mr. Laliman, near Bordeaux, are the "Ohio" or "Jaques." After considerable research, we find that Mr. G. Onderdonk, the pioneer fruit-grower of Western Texas, describes the *Lenoir* (original stock of which he had obtained from Berckmans) as follows: "*Bunches* large, long, loose; *berries* small, black, round; no pulp; vinous and much coloring matter; leaves lobed; a fine bearer and wine grape. And we would add that the leaf and habit exactly resemble those of the *Black Spanish*. We have never planted a variety that grew off better than this variety has done during the two years we have had it in cultivation. In 1873 we gathered fruit from this variety that had been ripe seventy days on the vine." From these facts we strongly incline to believe that *this Lenoir* is the variety our friends in France are looking for, and have received under the name of Jaques.

GRAFTING AS A MEANS OF COUNTERACTING THE WORK OF PHYLLOXERA.

The advantages of grafting are two well recognized to need enforcing. By its means, healthy, vigorous vines, which do not fruit well, may soon be made abundant bearers; new varieties and seedlings be quickly tested, and a less desirable variety replaced by one more desirable. Our knowledge of the Grape Phylloxera has of late pointed out other cogent advantages that may be derived from grafting, and it is in view of the renewed interest which I have found manifested in it among grape growers, that I venture a few remarks on a subject with which I have had little personal experience, but to which I have given some attention through observation and study of the experience of others.

Having shown that certain varieties of our grape vines have a far greater power of resisting the Phylloxera than have others, and that they represent all degrees of susceptibility, from those which invariably succumb in the course of two or three years, to those which are seldom affected, and never materially; I took occasion to urge judicious grafting as one of the most available means of coping with the disease; and also to request of those grape-growers who have the advancement of their calling at heart, and who are so circumstanced that they can make the trials, to institute experiments in grafting some of the most susceptible varieties. (See Rep. 6, pp 49, and 78–81.) As the report mentioned was not distributed till it was too late in the year for my request to be complied with, and as only the few of whom I made the request, through other means, have begun to carry out the suggestion, I take this opportunity of renewing it, and of offering a few remarks for guidance.

One important fact should always be borne in mind in this connection, and that is, that the Grape vine, having a very thin inner bark or liber, does not graft with the same ease as do the more common of our fruit trees, such as apple, pear, etc.: more care is, therefore, necessary in the operation.

Cleft grafting is the more ordinary mode employed, and it is usually done by digging away the earth, and inserting the graft very early in the Spring, two or three inches, or at the first smooth place below the surface. A horizontal cut of the stock is generally made, but a sloping one is, perhaps, preferable, from the fact that it enables all the gummy matter and excessive moisture which oozes from the cut, to run down, and not accumulate to the injury of the cion. Fuller recommends grafting in the Fall, and while this method is not deemed so advisable in Missouri, where there is such continued alternation of freezing and thawing, which is apt to lift the cion and separate it from the stock; yet I give his method in his own words, as recently published in the New York *Tribune:*

Select cions of the present year's growth, and from canes a quarter to three-eighths of an inch in diameter, and cut into lengths of three inches, with a bud near the upper end. The lower end should be made into a long, slender wedge. Remove the earth about the stock four to six inches, if the main branching roots will permit of this depth. Then cut off the vine a few inches below the surface and square across; then split it with a chisel or knife, making as smooth a cleft as possible for the reception of the wedge-shaped cion. If the stock is an inch or more in diameter, two cions may be needed, one on each side of the cleft.

The outer edge of the wood of the cion should be placed even with the outer edge of the wood of the stock, no attention being paid to the uniting of the two, because one will be very thick and the other thin. A nice fit of the two is essential, and in crooked-grained, gnarly stocks, a smooth, even cleft can only be made by cutting out the wood with a sharp instrument. But it does not matter how it is done if it is well done. After fitting the cions to stock, wind a strong cord about the two, in order to hold the former firm in place; then pack grafting clay or common soil about the stock, entirely covering the wound made and the lower half of the cion, but leaving the bud uncovered. No grafting wax should be employed in grafting grape vines. After the cions have been inserted as directed, invert a flower-pot or small box over the cion; upon this place a quantity of leaves, straw or hay; then cover all with earth, rounding it up in order to keep the water from settling around the grafted stock as well as to prevent too severe freezing.

Early in Spring remove the covering, and if the operation has been properly performed, the cion will be firmly united, and will push into growth as the season advances. I have had Delaware, Iona and similar varieties make a growth of from forty to sixty feet of vine from a single bud in one season, set in strong stocks in the manner described. Grafting in the Spring may be performed in the same manner, omitting the covering, but it should be done very early or after the leaves have started and growth begun. The cions, however, should be cut early and kept dormant in some cool place until wanted for use.

But valuable above all other experience for our own people, will be that of Mr. George Husmann, and as he has said little on the subject in his well known work, "Grapes and Wine," I take pleasure in giving that experience, as he has kindly communicated it to me:

Dear Sir: As you wished to have my views of grafting the vine, especially with the object of grafting some of our varieties most subject to the ravages of the Phylloxera upon roots of varieties which resist it, I will cheerfully add my mite to the researches which have already thrown so much light upon the history and the failure of so many of our otherwise most valuable varieties. My first attempt at grafting the vine were made in the Spring of 1852, nearly twenty-three years since, and were made by grafting the then rare varieties of Norton's Virginia and Herbemont upon five years old Isabella roots. I found in the first edition of A. J. Downing's "Fruits and Fruit Trees of America," a few remarks on the practicability of grafting the grape below the ground, which led me, then a novice in horticulture, to try it, and with eminent success. I took the ground away from the crown of the vine until I came to a smooth place, then cut off the stock, split it with a grafting chisel and inserted from one to two cions, according to size of stock, cut to a long wedge with shoulders on each side. I used no bandages, as the stocks were strong enough to hold the cions firmly, and only pressed moist earth on the cut to cover the wound. This was done on the 22d and 23d of March, and the cion covered and shaded to the top bud. About three-fourths of the grafts grew vigorously and fruited the next year. They have produced heavy crops ever since, and when at Hermann, a week ago, I still found them vigorous and healthy, while the Catawbas around them have "passed away" several years ago. I have practiced various methods since, with more or less success, and still think this the best and most practicable, though it is neither an easy nor a pleasant task, as it must be performed when the ground is still cold and moist, and requires a good deal of stooping. The inner bark or liber of the vine is very thin, while the outer bark is very thick on a large old stock. The success of the operation depends entirely on a good junction of the liber of stock and cion, and therefore requires a steady hand and a good eye to push the cion to its place. My friends, the venerable Fr. Muench and Samuel Miller, practice about the same method, and are both almost invariably successful. The cions should, if possible, be cut in Fall and kept on the north side of a building or fence, so as to remain dormant. Should the stock not be strong enough to hold the cion firmly, it should be tied with basswood bark, or an oblique cut be made instead of a split. This is preferable in small vines any way, as by so doing, the fibres of stock and cions are both cut obliquely, and therefore make a closer fit.

There are other different methods. Another, which I will mention here, has been practiced at Hermann with very good success, though I have not been very successful with it. It has the advantage of saving the vine, provided the graft does not take. It is done by simply making an oblique cut into the stock below the surface or crown, and inserting the cion, cut to a rather blunt wedge, by bending the stock to one side, and thereby opening the cut. If the cion takes, the stock is cut off above it. Another method is grafting under the bark later in the season, when the sap flows freely and the bark peels readily; a long, slanting cut is made on one side of the cion, the stock cut off square, the bark lifted with a knife, and the cion pushed down under it. Every one who has practiced budding will readily perform this operation. The stock is then tied with basswood bark. I have followed this plan with varied success later in the season, but prefer the first method. I think grafting above ground impracticable in our climate, on account of the high winds and drying influence of our Summer sun.

As to the advantages to be gained by grafting, they are manifold. They may be summed up as follows:

1. The facility it gives us to try and fruit new and rare kinds by grafting them on strong stocks of healthy varieties, where they will often make wood strong enough for fruiting the next season, and give us abundance of propagating wood, thus gaining more than a year.

2. Nearly every vineyard contains some worthless varieties, which are, however, strong and healthy growers. These can, by grafting, be changed into the most valuable varieties.

3. The facility by which varieties which are very difficult to propagate may be increased and multiplied, as nearly every variety will graft readily.

4. Last, but not least, it gives us a means of successfully combating the Phylloxera, as your experiments have so conclusively proven. If the Catawba and many of our other most valuable varieties, have deteriorated because this little insect has been to work on their roots, and the roots of other varieties are comparatively exempt from its ravages, the remedy would indeed be a very simple one. By planting such varieties as propagate readily, and also graft with ease, they could be changed by grafting the second Spring. I know, from experience, that slow growing varieties can be made to grow much more vigorously by grafting on stocks of strong and healthy growers. The most vigorous and productive Delaware I know around Hermann, was grafted on a Norton's Virginia, and produced an abundance of fine fruit, when Delawares on their own roots, in the same vineyard, dropped their leaves, and did not ripen their fruit. It is certainly of the utmost importance that experiments of this kind should be made, and I would advise all lovers of the Catawba and Delaware to try it.

But now the question arises, what stock shall we choose? The Clinton, though easy of growth, is a poor stock, as it suckers inveterately, and, besides, has not the affinity to most of our valuable varieties which makes them take readily on it. In fact, I do not consider any of the Riparia or Cordifolia class as good stocks, for Labrusca and its hybrids, or Æstivalis. But the Concord seems to me eminently the stock to graft upon. Easy of propagation, within the reach of every one, with the adaptability to any soil it possesses, and as nearly every variety will unite readily with it, it seems as if hardly a better one could be found. But were I to plant it for this purpose, I would take good, strong plants, say at least one foot long from the cutting to the crown, plant them with their roots one foot below the surface, and trim off the surface roots clean, only leaving the roots on the two lower joints. Then cultivate well for one year, and graft as near the surface as practicable to insure the life of the cion. Should the plants make roots above the junction, I would cut them smoothly close to the graft every Spring, and thus establish the plant entirely upon Concord roots.

This may seem very troublesome to our friends who plant vineyards entirely upon the easy plan, and let them take care of themselves. But I think that their days are numbered. This slovenly culture, or rather no culture at all, will never make us a wine producing country worthy of the name; and if we had not a single one of that stamp left among us, I believe we would be infinitely better off than we are now. If France can import millions over millions of our American varieties to regenerate her devastated vineyards, we can certainly afford to use the means ready at hand. Our American wines have a glorious future, and we have the material for the grandest results already. Last August I sent two boxes of assorted wines, fifteen varieties, made by Messrs. Poeschel & Scherer, at Hermann, to my French correspondent, Messrs. Douysset Fils, at Montpellier. I quote from a letter just received, the following: "We have duly received the wines of Mr. Husmann, and they were exhibited by us before the International Congress of Viticulture, just held at Montpellier, and tested by a committee of thirty members, officially appointed for that purpose. They were about the best connoisseurs of France. Norton's Virginia and Cynthiana, as red wines, Martha, Gœthe, and above all, Hermann and Rulander, as white wines, were highly praised; and the general opinion is, that after we have restocked our vineyards with American vines, we will not regret the loss of our own very much. As to Concord, Ives, Wilder, North Carolina, Clinton, Herbemont and Cunningham, they will very likely be generally planted in our black soils, and much used for stocks for our Aramons."

This was accompanied by an order for a million of Concord and all the Herbemont cuttings I could yet secure, as well as smaller orders for other varieties. When our products are thus appreciated in the greatest wine producing country we should throw sloth and sluggishness aside and go to work in good earnest and with all available means. Let none follow or commence grape growing in the future who are not willing to do their best. We want brains and skill, as well as muscle. We want close observation, indefatigable exertion and intelligent labor in the vineyard as well as in the wine cellar. It is my belief that the darkest days of American grape culture are over, and that the future will not fail to bring us glorious results if we labor for it faithfully.

Your labors have done a great deal to post us in regard to our insect enemies and friends, and should be gratefully appreciated by every grape grower, while all should do their part in sending you specimens and observing their habits.

GEO. HUSMANN.

Sedalia, Mo., December 20, 1874.

It will be noticed that the above experience and directions refer solely to grafting underground. Both Fuller and Husmann deem grafting above ground impracticable in our climate, principally on account of our winds; and their advice has been so very generally followed that little attention has been given to this mode of grafting the grape vine. The consequence is that we have the most conflicting experience as to the results of grafting; for, by the underground methods, the graft will make its own roots in the course of a few years, unless very great pains are taken to prevent such an occurrence; that it has done so in the majority of cases of grafting in this country in the past, admits, I think, of little doubt. Yet, in grafting as a means of counteracting the Phylloxera, the first requisite is to prevent the graft from making any roots of its own; for it must be remembered that we are dealing with a root malady purely, and that the object is to grow those varieties whose roots succumb more or less to the attacks of the insect, by using the roots of those which resist;

this object is necessarily frustrated in proportion as the graft forms roots of its own.

There are two methods of grafting above ground, which I have every reason to believe may be made more successful than grape growers have hitherto been led to suppose. The first is by temporarily making a false surface and grafting in the ordinary manner just described, *i. e.*, instead of digging away the earth and inserting the cion two or three inches below ground, it should be inserted two or three inches above ground and the earth thrown up around it, to be removed only after the graft is thoroughly and permanently joined. There will then be no danger of the graft forming its own roots ; and it is certainly as easy to throw the earth around the vine as to dig it away, while the mechanical work can be much more conveniently and agreeably performed above than beneath the surface. No doubt this mode of grafting needs greater care to make it successful, especially in a very dry season, as the mound is more apt to dry out than the level ground. Yet there is not lacking evidence that this method will work well in our soil and climate. Mr. Jno. Vallet, of New Haven, a grape-grower of much experience, has had eminent success in thus grafting above ground, employing flax twine and paw-paw bark for bandaging. He considers that the vine grows more vigorously and that there is less danger of separating the graft when once formed, as there is no necessity for going below ground to destroy the suckers, the doing of which sometimes loosens the graft.*

The second method is by inarching. This system of grafting does not seem to have been much practiced in this country, yet while it requires great care, and success may not as often crown the effort as in the former methods, I hope more attention will in future be given to it.

The operation is comparatively simple : A slice two or three inches long is cut from one side of the vine to be grafted, and a similar slice from the vine which is to serve as stock, as near the base or butt as possible. The two cut portions are then brought face to face, so as to fit as neatly as possible, and are then bound together with cord, basswood bark or other grafting bandage, which should be kept

* Mr. Vallet informs me that in 1861 he grafted above ground for Emile Mallinckrodt, in St. Louis county, a number of Catawbas on Isabella stock; that they did admirably, and subsequently produced from 60 to 80 bunches to each vine. He also, in the same manner, in the years 1862 and 1863, grafted Delaware onto Isabella, 12 miles from St. Louis in Mr. Layton's vineyard on the Olive street plank road. The grafts did splendidly, and subsequently gave fine crops. By contrast to this experience, and interesting from the Phylloxera standpoint, he grafted for Miller & Bates, of New Haven, Virginia Seedling on Catawba, (1500 in 1866 and 1500 in 1867,) and no grapes resulted, only five per cent. of the grafts growing.

moist with moss. In the course of a fortnight partial unison takes place, when the bandage should be somewhat loosened to admit the expansion. In six or eight weeks, if the operation is successful, the stock and cion are firmly united, when the bandage may be removed. The graft immediately below the union and the stock immediately above it should then be partially severed, and in a week or so more, entirely cut loose.

While, as already stated, this mode has not been much practiced in America, sufficiently successful results have been obtained to encourage further trial; and, as an example, I will mention one instructive instance communicated by my friend Isidor Bush. One of his customers, Eugene Cambre, of Nauvoo, Ills., has for some time furnished him with a superior quality of Delaware wine; and being anxious to know how Mr. Cambre succeeded so well with the Delaware, when so many others in the same neighborhood failed with it, Mr. Bush inquired as to the reason, and found that it was Mr. Cambre's custom in planting a Delaware vineyard to plant alternately with a Delaware, a wild vine from the woods, and to subsequently transfer the Delaware onto the roots of the wildling, by this system of inarching.

The Delaware, as may be seen by the tabular statement in my last report, is among those which suffer materially from the Phylloxera, and several other cases of its successful growth when grafted onto wild vines, where on its own roots it failed, were elicited at the recent meeting of the Illinois State Horticultural Society, held at Peoria.

Mr. Cambre has very kindly communicated to me his method, but the following description of it, from the Grape Manual of Messrs. Bush & Son & Meissner, so well covers the ground that I give it in full:

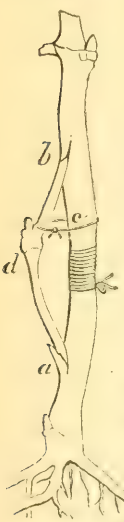
For this method it is desirable that two plants, one each of the variety which is to form the stock, and one of the scion, be planted close together, say about one foot apart. In June, (the first year, if the plants make a sufficiently strong growth, if not, the second year,) or as soon as the young shoots become sufficiently hard and woody to bear the knife, a shoot is taken from both the stock and the scion vine, and at a convenient place, where they may be brought in contact, a shaving is taken out from each of these, on the side next to the other, for a length of 2 to 3 inches. This must be done with a smooth cut of a sharp knife, a little deeper than the inner bark, so as to obtain on each a flat surface. They are then fitted snugly together, so that the inner bark joins as much as possible, and wrapped securely with some old calico torn in strips, or soft bass strings. Besides this, it is well to place one tie a little below, and one above the grafted point, and also to tie the united canes to a stake or trellis to insure against all chances of loosening by the swaying of the wind. The rapid swelling of the young growth at this period of the year makes it desirable that the grafts be looked over after a few weeks, replacing such ties which may have burst, and loosening others which may bind so as to cut into the wood. A union will generally be made in the course of two or three weeks, which will be further consolidated in the course of 6 to 8 weeks, when the bandages may be removed and the grafted portion left exposed to the sun, to thoroughly harden and ripen it. The shoots themselves are to be left to grow undisturbed for the rest of the season. In the Fall, if a good union has taken place, the cane forming the scion is cut close *below* its union with the stock cane, which in its turn is cut close *above* the connection. Supposing the stock to have been a Concord and the scion a Delaware, we now have a vine of the latter entirely on the strong, vigorous root of the former. Of course constant vigilance must be exercised to prevent suckers from starting out of the stock. It is well to protect the grafted joint the first few winters by a slight covering of straw or soil to prevent the frost from splitting it apart.

Mr. Cambre in giving his experience writes: "I have positively abandoned cleft grafting; it is too much trouble and too uncertain, and the graft often makes its own roots. I assure you that from a long experience in inarching, I am of the opinion that not alone the Delaware but most of our cultivated varieties will do better on native wild roots than on their own. I have 14 acres of vines mostly grafted in this manner on wild stocks, and I have not lost one of such grafts. It is preferable to graft at from 10 to 15 inches from the ground."

Another mode of grafting above ground is thus given in "The Cultivation of the Grape," by W. C. Strong:

In *The Gardeners' Monthly*, Vol. II, p. 347, is a description of a mode practised with success by Mr. Cornelius, which we copy, not merely as it is interesting in itself, but also because it illustrates many other modifications in grafting:

[Fig. 20.]

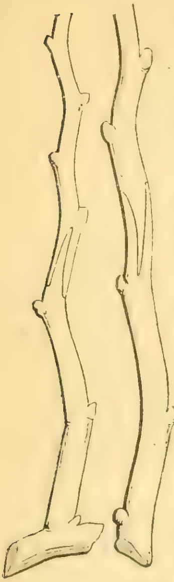


"After the first four or five leaves are formed, and the sap is flowing, you choose the place on the vine where you intend to graft. At that point wrap tightly a twine several times around the vine. This will, in a measure, prevent the return sap.

"Below the ligature make a sloping cut down, as shown at Figure 20, *a;* also, a similar reversed one above the ligature, as at *b*, about one inch in length. In selecting a scion prefer one that has naturally a bend. Cut it so that it shall be wedge shaped at both ends, and a little longer than the distance between the cuts in the vine at *a* and *b*. Insert the scion, taking care to have the barks in direct contact, securing it with a string, *c*, bound round both scion and vine sufficiently tight to force the scion ends into their places. If the work is done well, no tie will be required at *a* and *b*, but the joints should be covered with grafting wax. In a short time, the bud at *d* will commence its growth, after which you can by degrees remove all the growing shoots not belonging to the scion, and in course of the Summer you may cut off the wood above *b*, and in the Fall remove all above *a* on the stock, and above *c* on the scion.

Still another mode of grafting which has, I believe, seldom, if ever, been attempted in this part of the country, but which has been employed with much satisfaction the past year by a few vine growers in France, and especially by M. H. Bouschet, of Montpellier, remains to be mentioned. It is the Winter grafting of a cutting of such variety as is desired to grow, upon another which is to be used as stock, the combined cuttings being planted in the usual manner in Spring, leaving only the buds on the graft proper out of ground. This is very similar to our ordinary mode of making apple grafts; and while we have little or no experience in this country on which to base anticipations, the method is worthy of trial, and is illustrated at figure 21.

[Fig. 21.]



But not to weary with details, I here reaffirm my belief, strengthened by each further observation, and by every additional experience of the past year, that just as the working of the root-louse is the primal cause of failure of some of our choicest varieties of the Grape vine, so in judicious grafting we have the most available means of counteracting its work, and of thus growing successfully many of those kinds which cannot be grown in this latitude with any profit or success on their own roots.

The recommendation to use our most resistant varieties as stocks for the French vines in the districts ravaged by the Phylloxera have already been followed by large demands for such varieties by the people of those districts, and while we yet scarcely know how our vines will act under the new conditions in which they are placed, the uncertainty as to the results of judicious grafting here at home, scarcely presents itself, for everything augurs favorably.

I have not, in the foregoing paper, entered into the discussion of the special influence of the graft on the character of the root, and *vice versa*; because I believe that, while the one doubtless does manifest a certain special influence on the other; yet, for practical purposes, we know that it is so slight as hardly to be worth considering in this connection. The influences of the one on the other are almost entirely due to the abundance or lack of nutrition in the root, and present in the graft no other changes than those of greater or less development in the different parts of its growth; and not in the specific character or quality of the fruit. Geo. Gallesio, in his work on the Orange Family, in which he fully considers the influence of grafting, lays stress on these facts.

In conclusion, I again appeal to those of my grape-growing readers who have the opportunity, to make experiments in grafting the more susceptible on to the roots of the more resistant varieties, and, as a guide, I repeat the following list of varieties that it is desirous to test as stocks and as grafts:

ROOTS TO USE AS STOCK.

1. Concord.	5. Norton's Virginia.
2. Clinton.	6. Rentz.
3. Herbemont.	7. Cynthiana.
4. Cunningham.	8. Taylor.

VARIETIES TO GRAFT ON TO ANY OR ALL OF THE ABOVE.

Of First Importance.

1. Catawba.
2. Iona.
3. Delaware.
4. Wilder.
5. Goethe.
6. Any European vine.

Of Secondary Importance.

7. Ives.
8. Hartford Prolific.
9. Maxatawney.

This list is given wholly from the Phylloxera standpoint, and with a view to discover the real influence of the resisting on the nonresisting kinds. There are many grape-growers who will agree with Mr Husmann, who has so high an opinion of the Cynthiana, that to graft even the Catawba upon it would, as he has remarked to me, "appear like sacrilege." Others again will not think the Hartford and Ives, for instance, worth saving, since they do not deem them worth planting. But any of the experiments indicated—no matter what the quality of the fruit—will prove valuable as showing the influence of a root that is proof against Phylloxera on a vine which on its own roots suffers from it. Experience is not wanting to show that several of the susceptible *Labruscas*, and many hybrids with *vinifera* grow with excellent success on the vigorous roots of *æstivalis;* but let us increase the experience on this point in every direction possible. If the reader can make but one or two of these experiments, I shall consider it a favor to have him do so, and inform me precisely as to the number and varieties grafted, the method employed, the character of the soil and all other details of interest. My object is to have these experiments made on different soils and in different latitudes; and, in the course of two or three years, I hope to gather the results from all quarters, and we may thus be enabled to draw conclusions of much importance to grape-growers.

AMERICAN GRAPE-VINES ABROAD.

Having already referred (pp. 104, 114) to the large demand that has been made for some of our American vines to be used as stocks in the blighted districts of France,* it is only necessary to add that experience over there with such vines is by no means discouraging; and that it is not at all improbable that some of our varieties will be eventually grown there not only as stocks for the European *vinifera* but for their own grapes, just as they are to-day, on account of greater hardiness and vigor, superceding the European vines in some parts of Australia,

* Mr. Husmann estimates in the *Rural World* for January 9, 1875, that the importation of American cuttings into France, during the Winter of 1874–5 will amount to ten millions.

Of the varieties which have thus far given most satisfaction, may be mentioned the Herbemont, Cunningham, Clinton, Concord, and especially the variety called Jaques, and which, as we have already seen, is probably Lenoir.

APPENDIX.

SYNOPSIS OF THE AMERICAN SPECIES OF THE GENUS *PHYLLOXERA*, Fonscolombe.

[On account of the interest attaching to the Grape Phylloxera, or, as it is now very generally called, THE Phylloxera, I have prepared the following Synopsis of the N. A. species of the genus, and give it as it at first appeared in the *Comptes Rendus* of the Paris Academy of Science for December 14, 1874.]

1. P. VASTATRIX Planchon. *Pemphigus vitifoliæ* Fitch. *Peritymbia vitisana* Westwood. Forming galls on the leaves, and swellings on the roots of *Vitis*. Introduced into Europe and well known as the Grape Phylloxera.
2. P. RILEYI Lichtn. Mo. Ent. Rep. V, p. 66, note; ibid. VI, pp. 64 and 86. Living on the underside of the leaves, and hibernating on the stems of *Quercus alba*, *obtusiloba* and *bicolor*.
3. P. CARYÆFOLIÆ Fitch. N. Y. Ent. Rep. III, § 166. Forming conical galls, which open at the summit, on the upper side of the leaves of *Carya alba*.
4. P. CARYÆCAULIS (Fitch) *Pemphigus caryæcaulis* Fitch, ibid. § 163. *Daktylosphæra subellipticum* Shimer, Trans. Am. Ent. Soc. II, p. 389. *Dak. caryæ-magnum* Shimer, ibid. p. 391. Forming elongate, rather irregular, but generally ellipsoid smooth, green swellings of large size, on the petiole of the leaf of *Carya glabra* and *amara;* the gall subsequently cracking open and becoming black and contracted.
5. P. CARYÆVENÆ (Fitch). *Pemphigus ? caryævenæ* Fitch. N. Y. Ent. Rep. III, § 164. Forming plaits in the veins of the leaves of *Carya alba*, which plaits project up from the surface in an abruptly elevated keel upon the upper surface of the leaf, and with a mouth opening on the underside, the lips of which are wooly.
6. P. CARYÆ-SEMEN (Walsh). *Xerophylla caryæ-semen* Walsh. Proc. Ent. Soc. Phil., VI, p. 283. *Daktylosphæra caryæ-semen* Walsh, 1st Ann. Rep. as acting State Entomologist of Illinois, p. 23, note 1. *Dak. globosum* Shimer, Trans. Am. Ent. Soc., II, p. 391. Forming fuscous, minute, subglobular, seed-like galls on leaves of *Carya glabra,* the galls opening in a small nipple on the underside.
7. P. CARYÆ-GLOBULI Walsh, Proc. Ent. Soc. Phil. I, p. 309. *Daktylosphæra hemisphericum* Shimer, Trans. Am. Ent. Soc. II, p. 387. Forming hemispherical galls about 0.25 inch diameter on the upper surface of the leaves of *Carya glabra* and *alba*, the galls rather flat below, where they open in a slit.

8. P. SPINOSA (Shimer). *Dak. spinosum* Shimer, Trans. Am. Ent. Soc. II, p. 397. Forming large, irregular galls, covered with spines, on the petiole of the leaf of *Carya amara*, the galls opening beneath in an irregular, sinuate slit.
*9. P. CARYÆ-SEPTA (Shimer). *Dak. caryæ-septum*, ibid. p. 389. Forming flattened galls with a septum on the leaves of *Carya alba*, the galls opening both above and below. Probably only an abnormal form of No. 7.
10. P. FORCATA (Shimer). *Dak. forcatum* Shimer, ibid., p. 393. Forming galls much like those of No. 6, but larger.
11. P. DEPRESSA (Shimer). *Dak. depressum* Shimer, ibid., p. 390. Forming depressed galls on leaves of *Carya alba*, the gall opening below with a constricted mouth fringed with filaments. *Dak. coniferum* Shimer is, in all probability, the same.
*12. P. CONICA (Shimer). *Dak. conicum* Shimer, ibid., p. 390. Forming galls similar to No. 11, but without the fringe. Probably the same.
*13. P. CASTANEÆ (Haldeman). Fitch N. Y. Ent. Rep. III, § 200. Referred to *Chermes* by Haldeman, but undoubtedly a *Phylloxera*.

Those with a star (*) I am not personally familiar with, but I have no doubt they are good species. The others I am well acquainted with. We have also some undescribed species, the three following of which are so characteristic that I will briefly describe their galls:

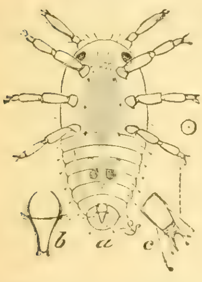
14. P. CARYÆ-GUMMOSA N. sp. Forming pedunculated, ovoid or globular galls on underside of *Carya alba*; the gall white, pubescent, and gummy or sticky, opening below in a fibrous point. The eggs are almost spherical, pale and translucent. Larva, mother-louse and pupa quite pale, the red eyes and eyelets strongly contrasting. The winged insects with difficulty distinguished from some of the other species, a difficulty made all the greater from the fact that other species get caught in the sticky surface of the gall.
15. P. CARYÆ-REN N. sp. Forming numerous, more or less confluent, mostly reniform galls on the petiole and leaf stems of *Carya glabra*; the galls varying from 0.2 to 0.7 inch in diameter, pale green and densely pubescent, and opening in a slit the whole of their length, transversely with the axis of the petiole.
16. P. CARYÆ-FALLAX N. sp. Forming conical galls thickly crowded on the upper surface of the leaves of the *Carya alba*. Strongly resembling No. 3 (*caryæ-foliæ*) but the hight one-third greater than the basal diameter, and opening below, instead of above, in a circular fuzzy mouth. This is the species briefly referred to under the same name by Walsh, First Ann. Rep. etc., p. 23, note.

Thus we have at least sixteen good, undoubted species inhabiting the United States. Most of them are more easily distinguished, as is often the case with *Cynipidæ* in Hymenoptera, and *Cecidomyidæ*, in Diptera, by their habits and the peculiar galls they form, than by colorational or structural differences. In fact all the species, except, perhaps, Nos. 1 and 2, yet need more careful and discriminating study and descriptions, in all stages from the living material.

THE AMERICAN OAK PHYLLOXERA—*Phylloxera Rileyi* Lichtn.

Through the kind assistance of Miss Mary E. Murtfeldt, who, at my request, watched this species most closely and assiduously from its awakening to activity in the Spring till its dormancy in the Fall, and was thus enabled to supplement my own observations which were unavoidably interrupted by other duties, I have been able to add many positive facts to what was previously known of its natural history—facts which are interesting and valuable in this connection as throwing light on the natural history of the congeneric Grape species. Undergoing all its changes above ground, the evolution of the Oak Phylloxera is much more easily studied than is that of the Grape Phylloxera; and I have had better fortune in obtaining the sexual individuals from the winged females, though the few specimens mounted so as to be of any value for description, are all males. These beings are so excessively minute that their study is attended with many difficulties, unless one can devote more time to it than has been at my disposal; yet, with the exception of the description of the true female, its natural history may now be considered complete; while the thorough observations of Balbiani on the closely allied European *Phylloxera quercus** Fonsc., will supply inferentially the missing data. We saw last year that the American Oak Phylloxera hibernates in the larva state attached to the twigs. "As the leaves begin to put forth, our young Oak Phylloxera cast off their Winter skin, and their lethargy with it. They may then be seen crawling up and down the twigs, but do not settle on the leaves. Attaining, in a few days, full growth, they begin a virginal reproduction by covering the twigs with eggs, which hatch in just about a week if the weather is warm and propitious. Thus the hibernating lice acquire their growth, and give birth to the first generation, in the short space intervening between the opening of the buds and the full growth of the first leaves."—[6th Report, p. 65. This first generation, which is sufficiently numerous, as the hibernating mothers are very prolific, disperses over the leaves, and one generation of parthenogenetic wingless females, follows another till the fifth or sixth, when, from the middle to the end of July, the winged females begin to appear. There is the same diminution in fecundity, until the appearance of the winged individuals that has been observed by Balbiani in the European *quercus;* and the winged females, just as in the other species, bear only a few eggs of two sizes, which give birth to the sexual individuals. These pair and the female lays the solitary egg, which gives birth to the normal parthenogenetic mother, which hibernates as a larva. The variation to which the species is subject; or rather the different forms which it presents, will be appreciated by the scientific reader from the following specific diagnosis:

[Fig. 22.]



Male Phylloxera Rileyi, showing genital organ (*b*) and tarsus (*c*); the dot at side showing natural size.

SPECIFIC DIAGNOSIS OF PHYLLOXERA RILEYI Lichtn.

Apterous, agamous ♀; normal form (*a*):—

Length, 0.016 inch, or rather more than 1-3 as large as *vastatrix*, with which it agrees in color. Proportionally more slender, with the abdomen more tapering. Body insected and covered with tubercles very much as in wingless *radicicola* form of *vastatrix*, but with an additional pair on the head, and those on the seventh abdominal joint always distinct. These tubercles concolorous with the body, fleshy, more or less elongate—from 1-12—1-6 the width of middle body—and surmounted at tip with a short, dark hair. The anterior tubercles longest; the lateral outline showing a series of thirty-six such tubercles, nearly equidistant, springing at about right angles from surface. The intermediate dark points, on thoracic insections, also as in *vastatrix*. Antennæ precisely as in *vastatrix*. Legs with the ends of tibiæ more swollen, and the claws more prominent. Venter, with a dusty tubercle just inside each coxa.

* There is some confusion as to what should really be considered the *quercus* of Fonscolombe, and Signoret, Balbiani and Lichtenstein have each in turn recently endeavored to define the European species. Signoret would reduce them all to three (*Comptes Rendus*, Dec. 7, 1874), as follows: 1. *Ph. quercus* Fonsc.=*Balbianii* Lichtn.=*coccinea* Balb. 2. *Ph. coccinea* Kalt.=*quercus* (Sign.)=*coccinea* Hayden. 3. *Ph. corticalis* Kalt.=*Lichtensteinii* Balb.=*Rileyi* Lichtn. Lichtenstein, on the contrary, makes four species (*ibid*, Feb. 8, 1875), as follows: 1. *Ph. quercus* Fonsc.=*coccinea* Hayden. 2. *Ph. Rileyi* Lichtn.=*corticalis* Kollar.=*Lichtensteinii* Balb. 3. *Ph. Balbianii* Licht. 4. *Ph. acanthochermes* Kollar.=*scutifera* Sign. In either event the genus is much more poorly represented there than in America. I would remark here also that I very much doubt whether our American Oak species occurs in Europe, however closely the *corticalis*, which differs in habit, may resemble it in appearance.

Deep yellow Form, with longer, roughened Tubercles (b):—

As frequent as *a* in July, and differing in the deeper color, inclining to brown, and in the greater length, irregularity, and darker color of tubercles: these tubercles are generally longest on middle body, and appear quite dark under a pocket lense; under the microscope they appear quite roughened with fleshy points from the sides toward the swollen base, and around the somewhat blunt, and sometimes slightly swollen tip.

Black Form, with very long Tubercles (c):—

With the body dark brown and the tubercles almost black; the dorsal ones, especially in middle of body, very long—half the diameter of body—slender, gradually tapering to tip, the lateral ones and some of the dorsal ones, less tapering and half as long. Antennæ with the third joint quite long and slender.

Pupa, normal Form (d):—

With the tubercles prominent, and the pale, mesothoracic portion occupying more of the body than in *vastatrix*.

Smooth Form (e):—

More elongate, paler, without tubercles. Only occasionally met with.

Winged, agamous ♀ (f):—

With the dark, mesothoracic band much as in *vastatrix;* the wings more slender, and somewhat more fuliginous, with the costal angle more produced and blunt, and the hook larger on secondaries; the antennæ with the third joint and the horny parts proportionally longer. Also presenting two forms of body and wings as in *vastatrix*.

Male (g):—

Not much larger than the newly-hatched larva; without tubercles, having but a few faint, hair-like points in their stead: the two tarsal claws distinct, but the basal joint of tarsus obsolete: the antennæ simple (at least there is, if anything, but the faintest trace of a small plate at tip): no sign of mouth-parts; the venter sometimes shows two opaque spots about middle, and the penis is quite conspicuous, the external parts seeming to consist of a tubercle which is bulbous at base, but pointed at tip, and of two dusky, apparently horny processes which run down each side as if to protect it.*

(The eight specimens obtained from winged ♀, which I have mounted, all seem to be of one sex, unfortunately, and no ♀ is among them.)

Newly-hatched Larva (h):—

Nearly smooth, with dark limbs and eyes, the tubercles indicated by slight swellings, which are, however, surmounted with a longer fleshy hair. The proboscis reaching beyond tip of abdomen.

Hibernating Larva (i):—

With the tubercles quite large, smooth, and surmounted at tip with a single spinous hair.

The true female yet remains to be described. Most entomologists would consider the forms *c* and *e* as specifically distinct from *Rileyi*—so abdormal do they appear: but a careful Summer's study of our Oak Phylloxera leads me to the conclusion that they are but forms of one and the only species occurring on the Oak in America. In fact, the polymorphism of these insects is not yet sufficiently appreciated even among entomologists; and I am strongly inclined to believe that the discussion about the different species occurring on Oak in Europe, is based, in great part, on the variations of a single species. The tubercles in *Rileyi* vary somewhat with each molt, and I have come to look upon the paleness or intensity of color as of little specific value.

At least five generations intervene from the mothers which hibernate to the winged form appearing first in July; and, from having enclosed some of the first winged females in muslin bags covering leaves that were carefully freed of all insect life; and having subsequently found such leaves infested with the ordinary agamous female with her progeny in all stages, there is reason to believe that the winged mothers may

* These males are so very minute, that the generative organ is not easily resolved, and presents a different appearance, according to position on the slide; but in most cases I could discern these dusky processes with sufficient distinctness.

be produced twice a year; *i. e.* there are two full cycles of development annually. It is quite evident to me, however, that there is no great regularity as to the time of the appearance of either the winged or sexual individuals; or even as to the number of generations intervening between two generations of winged mothers: so much depends on conditions, and the species is so easily influenced in its development by the character of the weather and food conditions. Thus, the winged mothers are much more abundant on young trees with tender succulent foliage than on the tougher leaves of the larger trees; and I am pretty confident that it is no particular generation that hibernates; but that it may be either the first, second, third, etc., from the impregnated egg, according as we have early or late cold weather. From August the insects continue to grow and multiply, with decreasing rapidity however, until the leaves commence to turn. The mothers then gradually perish and the young forsake the leaves and crowd around the stems; this happening in 1874, from the middle to the end of October.

Whether with this species, as in the case of the Grape, and the European Oak species, some of the wingless, agamous females also lay the sexual eggs precisely as do the winged females, I have not yet ascertained; though I have no reason to doubt that such will prove to be the case.

THE ROCKY MOUNTAIN LOCUST—*Caloptenus spretus* Thomas.*

(Ord., ORTHOPTERA; Fam., ACRIDIDÆ.†)

This insect is a fit subject for the close of that portion of the present Report which comes under the head of "Noxious Insects." Few, indeed, are there more noxious than this plague of the West, which in 1874 proved a national calamity, reducing untold thousands to misery and distress. Feeling the importance of the subject, I spent some time in the ravaged districts of Kansas, and carefully studied the habits of the pest as it poured into our western counties.

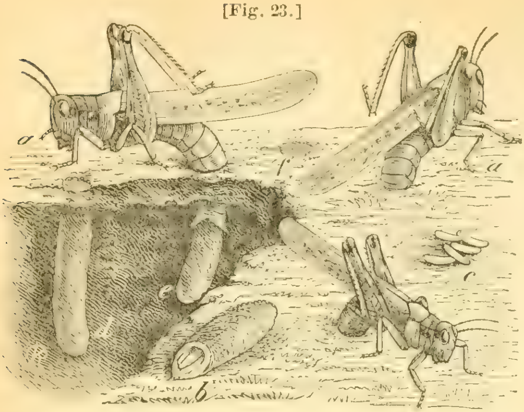
ITS NATURAL HISTORY.

The life-history of this insect is essentially the same as that of the more common locusts that are with us every year. The female, when about to lay her eggs, forces a hole in the ground by means of the two pairs of horny valves which open and shut at the tip of her abdomen, and which, from their peculiar structure, are admirably fitted

*The species was named in MS. by Mr. P. R. Uhler, of Baltimore, Md., but never by him described. Mr. B. D. Walsh subsequently (*Pract. Ent.* II, p. 1) adopted Mr. Uhler's name in connection with a partial description; but Mr. Thomas first fully defined the species, as here distinguished and referred to by me. The question as to the validity of the species will be discussed in the proper place.

† *Locustidæ* of Westwood.

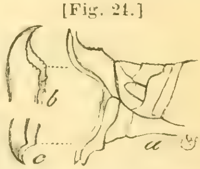
[Fig. 23.]



ROCKY MOUNTAIN LOCUST:—*a*, *a*, *a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end broken open, showing how the eggs are arranged; *c*, a few eggs lying loose on the ground; *d*, *e*, shows the earth partially removed, to illustrate an egg-mass already in place, and one being placed; *f*, shows where such a mass has been covered up.

for the purpose. (See Fig. 24, where *b*, *c* show the structure of one of each of the upper and lower valves). With the valves closed she pushes the tips in the ground, and by a series of muscular efforts and the continued opening and shutting of the valves, she drills a hole until, in a few minutes (the time varying with the nature of the soil) the whole abdomen is buried, the tips reaching an inch or more below the surface, by means of great distention. Now, with hind legs hoisted straight above the back, and the shanks hugging more or less closely the thighs, she commences ovipositing, the eggs being voided in a pale, glistening and glutinous fluid which holds them together and binds them into a long cylindrical pod, covered with particles of earth which adhere to it. When fresh the whole mass is soft and moist, but it soon acquires a firmer consistency. It is often as long as the abdomen, and usually lies in a curved or slanting position. It is never placed much more than an inch below the surface, except where some vegetable root has been followed down and devoured, and the insect leaves her eggs before emerging; in this way the mass is sometimes placed a foot below the surface. The eggs which compose this mass are laid side by side to the number of from 30 to 100, according to size of mass. They are 0.15 to 0.20 inch long, one-fourth as wide, slightly curved, of a pale yellow color, and rather larger at the anterior than the posterior end. As the hatching period approaches, they become more plump and pale, and the embryo, with its dark eyes, is visible through the shell which is now somewhat transparent. The opening to this egg-mass is covered up by the mother, but the newly hatched insect has no difficulty in escaping. When first hatched the little hopper is quite pale, but soon becomes mottled with gray and brown. In escaping from the egg it is at first covered with a delicate

[Fig. 24.]



ROCKY MOUNTAIN LOCUST:—Anal characters of female, showing horny valves.

[Fig. 25.]

ROCKY MOUNTAIN LOCUST:—*a*, *a*, newly hatched larvæ; *b*, full grown larva; *c*, pupa.

white pellicle which has to be cast off before there can be freedom of motion; so that the insect may be said to molt as soon as it is born. Except in having a narrower pro-thorax, sloping roof-fashion to a median ridge, and in lacking wings, the young locust scarcely differs in structure from its parent; and the perfect winged form is gradually assumed through a series of four molts, during the first three of which the wing-pads become larger, and during the last, from the pupa (Fig. 25, *c*,) to the perfect state, the thorax becomes flattened, the wings are acquired and the insect ceases to grow and is ready to procreate. The time required from hatching till the wings are obtained averages about two months. The high and long flights characteristic to the species after the wings are acquired, are seldom indulged, except when there is a fair wind.

Just as the mature insects fly, as a rule, in a southeasterly direction, so the young, soon after they hatch, manifest the same desire to move toward the southeast. They are most active in the heat of the day, but are perhaps more ravenous at night. They migrate short distances every clear day, but do not like to cross a stream unless they can jump it. If driven into water, however, they kick about, making considerable progress, and do not easily drown. Such at least are the habits of the young hatched in the Mississippi Valley, though it is very probable that in their native table lands of the mountain region the migrating habit is not developed till they have acquired wings, and are forced from hunger to seek new quarters.

THE EGGS ARE LAID BY PREFERENCE

In bare, sandy places, especially on high, dry ground, which is tolerably compact and not loose. It is generally stated that they are not laid in meadows and pastures, and that hard road-tracks are preferred; in truth, however, meadows and pastures, where the grass is closely grazed are much used for ovipositing by the female, while on well traveled roads she seldom gets time to fulfill the act without being disturbed. Thus a well traveled road may present the appearance of being perfectly honey-combed with holes, when an examination will show that most of them are unfinished, and contain no eggs; whereas a field covered with grass-stubble may show no signs of such holes and yet abound with eggs. Furthermore, the insects are more readily noticed at their work along roads and roadsides than in fields, a fact which has also had something to do in forming the popular impression. Newly broken or plowed land is not liked; it presents too loose a surface. Moist or wet ground is always avoided for the purpose under consideration. During the operation the female is very intent on her work and may be gently approached without becoming alarmed, though when suddenly disturbed she makes great efforts to get away and extricates her abdomen in the course of half a minute or more.

THE MIGRATORY INSTINCT AND GREAT DESTRUCTIVE POWER BELONG TO BUT ONE SPECIES WEST OF THE MISSISSIPPI.

Being anxious to ascertain whether the injuries reported in the different parts of the country between the Mississippi and the Rocky Mountains were all caused by one species, or whether others joined their forces in devastating the country, I took some pains to procure specimens from as many different localities as possible. What with specimens collected in previous years in Colorado, and received from Missouri and Texas, and those obtained in 1874, I now have material from Manitoba, Minnesota, Nebraska, Iowa, Colorado, Kansas, Missouri, Indian Territory and Texas. In each instance it is the same species that proves such a scourge. As we shall presently see, the same species occurs in Wyoming, Utah, Idaho, Nevada, Montana and Arizona. I know nothing of the migratory species which at times does damage in California and other parts of the country west of the Rocky Mountains; some have supposed it to be *Œdipoda atrox* Scudder; but I agree with Mr. Thomas that, with its comparatively short wings, this species cannot sustain lengthened flight, and the probability is that the *spretus* under consideration, or a race of it, is the culprit.

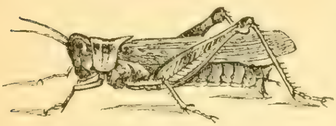
Only occasionally do specimens of some of the more common species accompany the migratory one. Thus the larger and common species, the Two-striped Locust (*Caloptenus bivittatus*, Say) and the Differential Locust (*C. differentialis*, Walk.) which are incapable of migrating to any great distance, and which are common in the Mississippi Valley, have occasionally been caught with the *spretus*, and sent to me with it. Already existing in the country invaded by the Rocky Mountain species, they were simply gathered up with it.

Yet, while no other species possesses such wonderful migratory habits, several become so enormously multiplied during certain years in their native homes as to commit very serious injury to vegetation. Of these, I shall speak more fully further on.

EASILY CONFOUNDED WITH THE RED-LEGGED LOCUST.

In my endeavors to accurately map out the territory in our State invaded in 1874 by the Rocky Mountain Locust, I have been frequently puzzled by accounts from counties east of the limit-line presently indicated. In every such instance, where I have been able to obtain specimens, they proved to be the common Red-legged Locust.

[Fig. 26.]



Red-legged Locust.

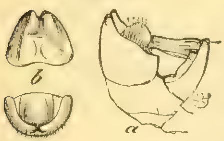
This last species is common in most of the States, extending to the Atlantic, and is even reported in parts of the Rocky Mountain region, where the Migratory species is at home. The two bear such a close general resemblance that even entomologists have doubted their specific distinctness; and indeed size and colorational characters would not suffice to separate the exceptional individuals which depart most from the typical characters of their species, and approach most

[Fig. 27.]

Rocky Mountain Locust.

to those of the other. Yet they are distinct, as species go, and in order to properly study the distribution of the Rocky Mountain species, and its power of becoming acclimated in the Mississippi Valley or not, it is of the first importance that observers confound not the two species. Hence, I shall describe in detail the two insects. From these details, which follow, it is evident that the distinguishing

[Fig. 28.]



Rocky Mountain Locust:—Anal characters of male; *a*, side view; *b*, *c*, hind and top views, of tip.

[Fig. 29.]

Red-legged Locust: Anal characters of male; *a*, side view; *b*, *c*, hind and top views, of tip.

characters, most easily observed by the non-entomologist, are the relative length of wing, and the structure of the terminal joint of the male abdomen, which is turned up like the prow of a ship —this last character being the most important and constant. The Rocky Mountain species has the wings extending, when closed, about one-third their length beyond the tip of the abdomen, and the last or upturned joint of the abdomen narrowing like the prow of a canoe, and notched or produced into two tubercles at top. The wings of the Red-legged Locust extend, on an average, about one-sixth their length beyond the tip of the abdomen, and the last abdominal joint is shorter, broader, more squarely cut off at top, without terminal tubercles, and looking more like the stern of a barge.

DESCRIPTIVE.

The large amount of material above referred to has enabled me to make very thorough comparisons between the two species. The genus *Coloptenus* to which the species belongs, is distinguished principally by the stoutness of the spine-like tubercle on the fore-breast between the front legs, and by the tip of the abdomen in the male being much swollen. Mr. Cyrus Thomas, in his admirable work on the "Acrididæ of N. A." has published good descriptions of the known N. A. species, and I will transfer what he has said of the two in question—adding only some subsidiary remarks in brackets, and at the close:

COLOPTENUS FEMUR-RUBRUM, Burm. Handb. Ent., II, 638.
Syn. *Acridium femur-rubrum*, Deg. Ins., III, Pl. 42, Fig. 5, p. 498.
" *femorale*, Oliv.. Encyl. Meth., 121 Ins. VI, 228.
Gryllus (*Locusta*) *erythropus*, Gmel., Linn. Syst. Nat. I, IV, 2086.

"Grizzled with dirty olive and brown; a black spot extending from the eyes along the sides of the thorax; [but never onto the third lobe]; an oblique yellow line on each side of the body beneath the wings; a row of dusky, brown spots along the middle of the wing-covers; and the hindmost shanks and feet blood-red, with black spines. The wings are transparent, with a very pale greenish-yellow tint next to the body, and are netted with brown lines. The hindmost thighs have two large spots on the upper side, and the extremity black [more correctly three such spots, or including the extreme one at tip, four: Harris seems to have overlooked the basal one]; but are red below, and yellow on the inside. The appendages at the tip of the body in the male are of a long triangular form. Length from [to tip of abdomen] 0.75 to 1 inch; expansion of wings 1.25 to 1.75 inches." As this species, which is so common, varies considerably, I have concluded to give Dr. Harris's description without change, adding the following: Vertex but slightly depressed, with a minute angular expansion in front of the eyes; frontal costa usually but slightly sulcate; sides parallel. Eyes large and rather prominent. Elytra and wings generally a little [usually extending about 1-6 their length beyond the abdomen] longer than the abdomen. The cerci of the male rather broad and flat [longer and narrower towards tip than in spretus]; apex of last ventral segment entire and truncate. The yellow stripes on the side extend from the base of the wing to the insertion of the posterior femora. The ground color varies with localities and age, and most of the specimens from one or two sections appear to have unspotted elytra; sometimes a reddish-brown tint prevails; at others a dark-olive; at others a dark purplish-brown; yet the markings generally remain the same.

Localities.—Maine, Massachusetts, Connecticut, New York, Pennsylvania, Maryland, Tennessee, Illinois, Minnesota, Ohio, Nebraska, Missouri, Kansas, Colorado, Wyoming, Vancouver's Island (?), west coast of America (?)—[Thomas, *Acrididæ* of N. A. (1873), pp. 163-4.

In addition to what Mr. Thomas states of the variation in color, it may be added that the dark marks on the hind thighs are in exceptional specimens wholly wanting, and in others so confluent that the whole of the upper part is brown-black. In order to show how variable (within certain limits, however,) is the relative length of wing, I will add measurements of over eighty specimens, all taken in St. Louis county. As the length of the abdomen is an uncertain criterion, varying according as this last is distended with eggs or contracted from one cause and another, I have made these measurements from the juncture of the hind thighs and shanks. The specimens were killed in the cyanide bottle, and while yet fresh and supple laid flat on a scale divided into hundredths of an inch. The furthermost hind leg was then stretched until the suture between shank and thigh was just visible above the inner border of the front wings. Careful measurements were then taken, first of the whole body, second of the extent of wing beyond the base of shank, third of extent of abdomen beyond the the same. It will be understood that as the abdomen shrinks slightly in drying, and the wings do not, the figures in the fourth column in all these tables are somewhat lower than if taken from dry specimens. The tables showing these measurements will prove interesting when compared with that further on, giving similar measurements of *spretus*, and conclusively show by comparing the figures in the fourth column that the specific distinction cannot, as Mr. Walsh thought, be safely and solely left to length of wing beyond the abdomen; as specimens of either species may approach each other in this respect to within the hundredth of an inch, and might be found to entirely agree if larger suites were compared. Nevertheless this relative length of wing has great value as a specific character, since of all the specimens measured, in even the longest winged *femur-rubrum* the wings fall short one hundredth of an inch of extending as far beyond the abdomen as they do in the shortest winged *spretus*. The anal characters of the male, (Fig. 29) will be found pretty constant and reliable. Yet they also vary and frequently approach *spretus* in the narrowing notched form of the tip. In the female the anal characters are of less value in distinguishing the species.

CALOPTENUS FEMUR-RUBRUM.

Measurements of the Male; in Hundredths of an Inch.

Whole length from front of head to tip of wing.	Length of wing beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of wing beyond tip of abdomen.
0.95	0.03	0.03	0.00
1.05	0.04	0.03	0.01
1.00	0.03	0.02	0.01
1.03	0.04	0.03	0.01
1.03	0.04	0.03	0.01
1.03	0.05	0.03	0.02
0.98	0.02	0.00	0.02
1.08	0.05	0.03	0.02
0.97	0.02	0.00	0.02
1.06	0.10	0.08	0.02
1.03	0.04	0.02	0.02
0.94	0.02	0.00	0.02
1.06	0.08	0.05	0.03
1.10	0.09	0.06	0.03
1.02	0.03	0.06	0.03
1.04	0.05	0.02	0.03
1.10	0.08	0.04	0.04
0.95	0.09	0.05	0.04
0.99	0.08	0.04	0.04
1.05	0.08	0.04	0.04
1.08	0.09	0.05	0.04
1 08	0.10	0.06	0.04
1.09	0.08	0.03	0.05
0.99	0.05	0.00	0.05
1.04	0.05	0.00	0.05
1.05	0.06	0.00	0.06
1.12	0.12	0.05	0.07
1.05	0.08	0.00	0.08
Measurements of Female.			
1.22	0.13	0.15	0.00
1.15	0.13	0.15	0.00
1.05	0.04	0.05	0.01
1.08	0.09	0.10	0.01
1.20	0.13	0.14	0.01
1.15	0.03	0.03	0.01
1.03	0.04	0.04	0.01
1.10	0.06	0.05	0.01
1.06	0.03	0.02	0.01
1.06	0.03	0.02	0.01
1.08	0.03	0.02	0.01
1.08	0.04	0.03	0.02
1.05	0.03	0.02	0.02
1.09	0.06	0.04	0.02
1.15	0.14	0.12	0.02
1.04	0.02	0.00	0.02
1.08	0.02	0.00	0.02
1.04	0.03	0.00	0.03
1.09	0.08	0.05	0.03
1.03	0.03	0.00	0.03
1.08	0.12	0.09	0.03
1.04	0.03	0.00	0.03
1.10	0.06	0.03	0.03
1.13	0.14	0.10	0.04

Measurements of Female—Continued.

Whole length from front of head to tip of wing.	Length of wing beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of wing beyond tip of abdomen.
1.13	0.08	0.01	0.01
1.08	0.04	0.00	0.04
1.13	0.09	0.05	0.04
1.18	0.12	0.08	0.04
1.13	0.09	0.05	0.04
1.15	0.13	0.08	0.05
1.09	0.08	0.03	0.05
1.15	0.13	0.08	0.05
1.19	0.15	0.10	0.05
1.19	0.14	0.09	0.05
1.04	0.05	0.00	0.05
1.19	0.14	0.08	0.06
1.15	0.14	0.08	0.06
1.18	0.08	0.02	0.06
1.18	0.14	0.08	0.06
1.13	0.09	0.03	0.06
1.13	0.09	0.02	0.07
1.06	0.10	0.03	0.07
1.09	0.10	0.03	0.07
1.13	0.10	0.03	0.07
1.15	0.10	0.03	0.07
1.15	0.08	0.00	0.08
1.12	0.08	0.00	0.08
1.14	0.15	0.06	0.09
1.18	0.09	0.00	0.09
1.10	0.13	0.04	0 09
1.16	0.12	0.03	0.09
1.19	0.23	0.12	0.11
1.15	0.14	0.03	0.11
1.13	0.12	0.00	0.12

CALOPTENUS SPRETUS Uhler Mss.

Syn., *Acridium spretum** Thos. Trans. Ill. St. Agr. Soc, V, 450.

Very much like *C. femur-rubrum*, Burm., the principal difference being in the length of the elytra and wings; a notch at the tip of the last [♂] ventral segment. Posterior lobe of the pronotum slightly expanding; median somewhat distinct. Elytra and wings pass the abdomen about one-third their length. The last [♂] ventral segment, which is turned up almost vertically, is somewhat tapering and is notched at the apex, which distinguishes it from the *femur-rubrum;* the notch is small, but is distinct. Prosternal spine robust, sub-cylindrical, transverse. Migratory.

Color.—Scarcely distinct from the *C. femur-rubrum.* The occiput and disk of the pronatum generally reddish-brown; the posterior lobe somewhat paler than the anterior and middle. Spots, as in *femur-rubrum*, arranged in a line along the middle of the elytra; these are a little larger and more abundant towards the apex. The head and thorax are sometimes a very dark olive-brown, at others, reddish-brown, and even brownish-yellow, the color deepening with age. The wings are pellucid, nerves dusky toward the apex; when flying high and against the sun, their wings look like large snow flakes.

Dimensions.—♀ Length, [to tip of abdomen] 1 to 1.2 inches; elytra as long as the body; posterior femora, 0.55 inch; posterior tibiæ, 0.5 inch. ♂ Length, 0.85 to 1 inch; elytra, 0.9 to 1.05 inches.

*This is called "*Acridium spretis*, Uhler" in the article alluded to, and I very much doubt if the description refers to the species in question; first, because I do not believe that *spretus* occurs in Murphysboro, Ills., where Mr. Thomas was then residing, and where he quotes *Acridium spretis* as being quite common; secondly because the description in some respects would not apply to *spretus* as at present defined. I call attention to this discrepancy, because it is upon this (as I believe erroneous) reference, that Mr. Thomas quotes *spretus* from Illinois; whereas I agree with Mr. Walsh that (as we understand the species to-day) it is not indigenous to that State. Where the anal characters of the male are not carefully given, it is impossible to be sure of the species.

Illinois, [very questionable], Iowa, Missouri, Nebraska, Kansas, Colorado, Wyoming, Utah, Idaho, Nevada, Montana, Minnesota, and Dakota. (Thomas, by examination and collections in person); Minnesota, Wisconsin [doubtful], Dakota (Scudder); Texas, Arizona, British America (Thomas)—[Thomas, *Acridida* of N. A., pp. 164–5.

Regarding coloration, as with *femur-rubrum*, it is quite variable, and the dead specimens convey a very imperfect idea of the living colors, which are thus given in my notes taken in the field. The more common specimens are yellowish-white beneath; glaucous across the breast and about mouth-parts; pale bluish-glaucous—often with shades of purple—on the sides of the head and thorax and on the front of the face; olive-brown on the top of head and thorax; pale beneath, more or less bluish above and marked with black, especially towards base, on the abdomen. The front wings have the ground-color pale grayish-yellow, inclining to green, and their spots and veins brown; the hind wings, except a yellowish or brownish shade at apex and along the front edge and a green tint at base, are transparent and colorless, with the veins brown. The front and middle legs are yellowish. The hind legs have the thighs striped with pale glaucous and reddish on the outside and upper half of inside, with four broad black or dusky marks on the upper edge, the terminal one extending beneath around the knee. The shanks are coral-red with black spines; the feet somewhat paler, with black claws; antennæ pale yellow; palpi tipped with black. In the dead specimens all these colors become more dingy and yellow. Palpi and front legs in some specimens tinged with red or blue; the hind tibiæ sometimes yellowish instead of red, especially in the middle.

Larva—When newly hatched, the larva is of a uniform pale gray without distinctive marks. It soon becomes mottled with the characteristic marks however. After the first molt the hind thighs are conspicuously marked on the upper outside with a longitudinal black line; the thorax is dark with the median dorsal carina and two distinct lateral stripes pale yellow, the black extending on the head behind the eyes. The sides of the thorax then become more yellow with each molt, the black on the hind thighs less pronounced, and the face at first black and then spotted. The occiput and abdomen above are mottled with brown, the former marked with a fine median, and two broader anteriorly converging pale lines, the latter with two rather broken lateral lines of the same color.

Pupa—The pupa is characterized by its paler, more yellow color, bringing more strongly into relief the black on the upper part of the thorax and behind the eyes; by the spotted nature of the face, especially along the ridges, by the isolation of the black subdorsal mark on the two anterior lobes of prothorax, and by the large size of the wing-pads, which—visible from the first molt and increasing with each subsequent molt—are now dark, with a distinct pale discal spot, and pale veins and borders. The hind shanks incline to bluish rather than red as in the mature insect.

In the following table of measurements, introduced for comparison with that given of *femur-rubrum*, the same rules were adopted as in the other case, and particular pains were taken to get specimens from as many parts of the ravaged country as possible; also, by study of the structural and other peculiarities of *spretus* to guard against the chance mixing of specimens of *femur-rubrum*.

CALOPTENUS SPRETUS.

Measurements of the Male; in Hundredths of an Inch.

Whole length from front of head to tip of wing.	Length of wing beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of wing beyond tip of abdomen.
1.24	0.25	0.05	0.20
1.20	0.28	0.08	0.20
1.29	0.28	0.08	0.20
1.18	0.33	0.12	0.21
1.26	0.25	0.03	0.22
1.22	0.29	0.06	0.23
1.10	0.29	0.05	0.24
1.33	0.29	0.04	0.25
1.33	0.35	0.09	0.26
1.24	0.29	0.03	0.26
1.29	0.35	0.08	0.27
1.30	0.32	0.05	0.27
1.30	0.35	0.08	0 27
1.28	0.35	0.08	0.27
1.29	0.32	0.05	0.27
1.24	0.30	0.03	0.27
1.19	0.33	0.06	0.27
1.28	0.36	0.09	0.27
1.28	0.30	0.02	0.28
1.24	0.38	0.09	0.29
1.35	0.39	0.10	0.29
1.23	0.38	0.09	0.29
1.35	0.35	0.05	0.30
1.35	0.40	0.10	0.30
1.35	0.34	0.03	0.31
1.30	0.34	0.03	0.31
1.33	0.33	0.02	0.31
1.25	0.34	0.03	0.31
1.32	0.34	0.03	0.31
1.30	0.34	0.03	0.31
1.18	0.34	0.02	0.32
1.38	0.40	0.08	0.32
1.38	0.42	0.09	0.33
1.40	0.38	0.05	0.33
1.28	0.38	0.05	0.33
1.30	0.35	0.02	0.33
1.24	0.38	0.04	0.34
1.30	0.38	0.03	0.35
1.40	0.38	0.03	0.35
1.33	0.35	0.00	0.35
1.33	0.38	0.03	0.35
1.35	0.38	0.02	0.36
1.34	0.38	0.02	0.36
1.29	0.38	0.02	0.36
1.33	0.35	0.02	0.37
1.36	0.43	0.06	0.37
1.38	0.34	0.05	0.39
1.33	0.36	0.03	0.39

Measurements of Female.

1.25	0.28	0.15	0.13
1.23	0.33	0.18	0.15
1.28	0.40	0.23	0.17
1.34	0.30	0.12	0.18
1.38	0.40	0.22	0.18
1.29	0.24	0.06	0.18
1.33	0.38	0.19	0.19
1.44	0.38	0.19	0.19
1.25	0.39	0.19	0 20
1.38	0.43	0.23	0.20
1.24	0.33	0.13	0.20
1.25	0.32	0.12	0.20
1.15	0.33	0.13	0.20
1.35	0.42	0.20	0.22
1.28	0.40	0.18	0.22
1.30	0·40	0.18	0.22
1.33	0.43	0.20	0.23
1.29	0.28	0.05	0.23
1.35	0.33	0.10	0.23
1.16	0.36	0.13	0.23
1.48	0.38	0.15	0.23

Measurements of Female—Continued.

Whole length from front of head to tip of wing.	Length of wing beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of wing beyond tip of abdomen.
1.28	0.38	0.15	0·23
1.30	0.36	0.13	0 23
1.29	0.36	0.12	0.24
1.30	0.42	0.18	0.24
1.33	0.28	0 04	0.24
1.35	0.32	0.08	0.24
1.33	0.39	0.15	0.24
1.30	0.42	0.18	0.24
1.35	0.43	0.19	0.24
1.26	0.30	0.06	0.24
1.38	0.40	0.16	0.24
1.33	0.36	0.12	0.24
1.24	0.33	0.08	0.25
1.29	0.38	0.13	0.25
1.45	0.43	0.18	0.25
1.50	0.43	0.18	0.25
1.33	0.33	0.08	0.25
1.30	0.43	0.18	0.25
1.30	0.33	0.08	0.25
1.25	0.30	0.04	0.26
1.30	0.35	0.09	0.26
1.28	0.32	0.06	0.26
1.34	0.30	0.04	0.26
1.36	0.34	0.08	0.26
1.25	0.38	0.12	0.26
1.45	0.52	0.16	0.26
1.45	0.44	0.18	0.26
1.25	0.30	0.04	0.26
1.39	0.45	0.18	0.27
1.52	0.40	0.13	0.27
1.26	0.36	0.09	0.27
1.28	0.40	0.13	0.27
1.28	0.35	0.08	0.27
1.33	0.33	0.06	0.27
1.33	0.35	0.08	0.27
1.28	0.35	0.08	0.27
1.26	0.39	0.12	0.27
1.38	0.42	0.15	0.17
1.30	0.40	0.13	0.27
1.23	0.35	0.08	0.27
1.43	0.30	0.02	0.28
1.29	0.36	0.08	0.28
1.28	0.38	0.10	0.28
1.30	0 36	0.08	0.28
1·35	0.43	0.15	0.28
1.30	0.43	0.15	0.28
1.33	0.38	0.10	0.28
1.38	0.42	0.13	0.29
1.15	0.38	0.09	0.29
1.38	0:42	0.13	0.29
1.35	0.42	0.13	0.29
1.36	0.39	0.10	0.29
1.29	0.38	0.09	0.29
1.38	0.43	0.14	0.29
1.28	0.38	0.09	0.29
1.33	0.39	0.10	0.29
1.36	0.34	0.04	0.30
1.45	0.43	0.13	0.30
1.38	0.33	0.03	0.30
1.35	0.40	0.10	0.30
1.38	0.39	0.08	0.31
1.29	0.35	0.04	0.31
1.38	0.35	0.03	0.32
1.42	0.48	0.16	0.32
1.30	0.40	0.18	0.32
1.43	0.38	0.06	0.32
1.25	0.35	0.03	0.32
1.46	0.44	0.12	0.32
1.33	0.36	0.04	0.32
1.24	0.36	0.03	0.33
1.34	0.45	0.12	0.33
1.35	0.43	0.10	0.33
1.35	0.45	0.10	0.35
1.32	0.38	0.03	0.35
1.33	0.38	0.03	0.35
1.43	0.45	0.10	0.35
1.38	0.42	0.04	0.38
1.53	0.49	0.10	0.39

Finally, to sum up the differences between the two species, besides the structural and more reliable characters already given, in general terms, *spretus* compared to *femur-rubrum*, may be distinguished by the following less reliable and more inconstant characters: It is the larger species; the antennæ are slightly shorter and paler; the occiput and two anterior lobes of the prothorax are more livid and darker; the third lobe of prothorax broader; the dark, subdorsal, prothoracic mark running from the eyes less pronounced; the oblique, yellow line from base of wings to base of hind thighs more often obsolete; the front wings paler toward tips, more ferruginous at base, with larger, more conspicuous spots; the anal abdominal joint of male also much paler; the cerci and valves in the female generally shorter and more robust.

Such are the distinguishing features between these two insects, when the more typical specimens of the western *spretus* are compared with *femur-rubrum* as it occurs around St. Louis. That these distinguishing features will lose their value in proportion as abundant material from all parts of the country is examined and compared, I have not the least doubt; for I have already shown that such is the fact so far as coloration and length of wing is concerned, and the meagre material which I have from the East indicates considerable variation and approach in the more important structural characters. In considering the ravages of migratory locusts in the Atlantic States, I shall recur to this subject.

CHRONOLOGICAL HISTORY.

The plague of locusts is as old, nay older, than the Bible, where, in Exodus, we are told how they went up over the land of Egypt and "covered the face of the whole earth, so that the land was darkened; and they did eat every herb of the land, and all the fruit of the trees which the hail had left; and there remained not any green thing in the trees, or in the herbs of the field, throughout all the land of Egypt."* Paulus Orosius tells us that in the year of the world 3,800, such infinite myriads of locusts were blown from the coast of Africa into the sea and drowned, that, being cast upon the shore, they emitted a stench greater than could have been produced by the carcasses of one hundred thousand men, and caused a general pestilence.† Numerous, indeed, are the accounts of general devastation, pestilence and famine that have frequently followed in the wake of these locusts in the East, and travelers in South Africa, Asia and South Europe, have left us abundant records of the fearful devastations of this "Army of the Great God," as the Arabs term these migrating hosts. Their history is one of dire calamity and desolation; and their devastations have become part of the history of nations: they have even been perpetuated in coins. Those who have the curiosity to acquaint themselves with the history of locusts in the more ancient parts of the world, cannot do better than refer to Kirby and Spence,‡

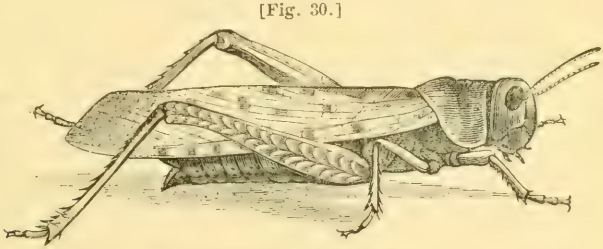
* Exodus, X, 15.

† Oros, *Contra Pag.* 1, V., c. 2.

‡ Introduction to Ent. I., Letter VII., London, 1828.

or to the compilation published in this country by Frank Cowan.* It suffices here to state that the injuries by locusts in the desert countries bordering mountain ranges in the East, are by no means matters of past history only, but that they are felt occasionally at the present time as they have been for all time past. In 1866, during the same year as our previous great invasion, Algeria and the whole country in the north of Africa, was severely visited, causing the famine of 1867, and the epidemics which followed; and even in 1874, these insects caused serious alarm in the same parts of Africa; and M. H. Brocard tells us that in the three subdivisions of Constantine, Setif and Batna, 4,820 hectolitres (about 14,000 bushels) of eggs were collected.† The species most conspicuous in its devastations, especially in Central Europe, is the Migratory Locust (*Œdipoda migratoria*, Linn), though in Africa and Asia the *Acridium perigrinum* and the *Caloptenus Italicus* have similar destructive and migratory powers. All these insects belong to the same family as our own species, and the last named, even to the same genus.

[Fig. 30.]



MIGRATORY LOCUST OF EUROPE.

While the chronological record of Locust invasions and devastations in the "Old World," is full and complete, the record of such invasions in our own country, has never been fully written. The most complete record that I know of, is that by Alexander S. Taylor, of Monterey, Cal., published in the Smithsonian Report for 1858, (pp. 200–213), to which I am indebted for the earlier accounts, which follow: From what is here given, it is very evident that these insects have occasionally proved great plagues from the earliest settlement of the country; and there can be no doubt that from time immemorial, or since our continent assumed its present configuration, they have from time to time played the same róle of devastators, and that the only exceptional circumstance about the 1874 irruption, compared to those of former years, was the larger area of settled and cultivated country devastated, and the consequent greater amount of distress entailed.

* Curious History of Insects, pp. 101—31, Phila., 1865.

† *Comptes Rendus*, Paris Academy, Jan. 25, 1875.

The earliest record I can find of Locust injuries in America, is in Gage's West Indies, and they date back to the year 1632. In speaking of their visitation in Guatemala, he says:

"The first year of my abiding there it pleased God to send one of the plagues of Egypt to that country, which was of Locusts, which I had never seen till then. They were after the manner of our Grasshoppers, but somewhat bigger, which did fly about in numbers so thick and infinite that they did truly cover the face of the sun, and hinder the shining forth of the beams of that bright planet. Where they lighted, either upon trees or standing corn, there was nothing expected but ruin, destruction and barrenness; for the corn they devoured, the fruits of trees they ate and consumed, and hung so thick upon the branches that with their weight they tore them from the body. The highways were so covered with them that they startled the traveling mules with their fluttering about their heads and feet. My eyes were often struck with their wings as I rode along; and much ado I had to see my way, what with a montero wherewith I was fain to cover my face, what with the flight of them which were still before my eyes. Where they lighted in the mountains and highways, there they left behind them their young ones, which were found creeping upon the ground, ready to threaten such a second year's plague, if not prevented; wherefore all the towns were called, with spades, mattocks and shovels, to dig long trenches and therein to bury the young ones."

The early Jesuit missionaries of California have left numerous records of their injuries on the Pacific Coast. Father Michael del Barco records their visitations in California in 1722, 1746 and the three succeeding years; also in 1753, 1754, and 1765. Clavigero, in his History of California, also gives a very full description of these pests.

In 1827, 1828 and 1834, they destroyed all the crops in the rancheros and missions, and in 1838 and 1846, again did great damage in upper California. "For more than half a century they have troubled the Argentine Republic in South America. In a latitude corresponding with Louisiana and Texas, but in the southern hemisphere they have made agriculture worthless, and rendered the settlement of that magnificent country between the Andes and the Atlantic Ocean, by a dense population, impossible."* Dr. B. A. Gould gives a graphic account of a swarm of locusts in 1873 that devastated Cordoba, a swarm at least twenty miles in length and six miles in breadth, extending for an altitude of 5° like a thick, black trail of smoke.† Of the ravages of locusts in the Atlantic States, I shall speak more particularly in a future chapter: We have records of great injury from locusts in New Hampshire, Massachusetts and Vermont, at several periods during the latter part of the last century.

Coming now to the chronological history of the particular Rocky Mountain species in question, anything like substantial records fail us, and in order to give the following summary of its devastations during the present century, I have had to ransack the files of hun-

*Rev. Edw. Fontaine, in New Orleans *Times*, March, 1866.

†Amer. Journ. of Sc. Dec. 1873.

dreds of periodicals, and to depend on a number of fugitive articles published during the last twenty years.

In 1818 and 1819, according to Neill's History of Minnesota, vast hordes of grasshoppers appeared in Minnesota, eating everything in their course; in some cases the ground being covered three or four inches thick. In the same years they were extremely injurious in the Red River country in Manitoba. In 1820, or the succeeding year, we hear of them falling upon the western counties of Missouri, as described in the following items:

"We were informed by old residents of West Missouri and some of the Indians, that long ago, I think it was in 1820, there was just such a visitation of grasshoppers as is now afflicting us. They came in the Autumn by millions, devouring every green thing, but too late to do much harm. They literally filled the earth with their eggs, and then died. The next Spring they hatched out, but *did but little harm*, and when full-fledged left for parts unknown. Other districts of country have been visited by them, but so far as I could learn, they have done but little harm after the first year."—[S. T. Kelsey, Ottawa, (now of Hutchinson,) Kansas, in *Prairie Farmer*, June 15, 1867, p. 395.

A Missouri paper publishes a statement by an old settler, that great numbers of grasshoppers appeared in September, 1820, doing much damage. The next Spring they hatched out, *destroying the cotton, flax, hemp, wheat and tobacco crops*; but the corn escaped uninjured. About the middle of June they all disappeared, flying off in a southeast direction.—*Western Rural*, 1867.

It is reasonable to suppose that these 1820 swarms also ravaged Kansas and the country to the northwest, very much as they did in 1874, though no records of the fact are to be found, for the simple reason that the western country was unsettled by farmers. We know that the crops were destroyed in many parts of Manitoba during the same and the previous year, and the migrations of 1819 and 1820 must have been very similar to those of 1873 and 1874.

In 1845 and again in 1849, we have accounts, from various sources, of their swarming in Texas. In 1855 there was another very general irruption all over the western part of the continent. Says Mr. Taylor, in the Smithsonian Report already alluded to: "Up to the 11th of October, 1855, and commencing about the middle of May, these insects extended themselves over a space of the earth's surface much greater than has ever before been noted. They covered the entire Territories of Washington and Oregon, and every valley of the State of California, ranging from the Pacific Ocean to the eastern base of the Sierra Nevada; the entire Territories of Utah and New Mexico; the immense grassy prairies lying on the eastern slopes of the Rocky Mountains; the dry mountain valleys of the republic of Mexico, and the countries of Lower California and Central America; and also, those portions of the State of Texas which resemble, in physical charactertstics, Utah and California. The records prove that the locusts extended themselves, in one year, over a surface comprised within thirty-eight degrees of latitude, and, in the broadest part, eighteen degrees of longitude.

"On several days in June, July and August, of 1855, the grasshoppers (or *langostas* of the Spaniards) were seen in such incredible numbers in the valley of Sacramento, in California; in the valley of Colima, in Southwest Mexico; in the valley of the Great Salt Lake; in Western Texas, and in certain valleys of Central America, that they filled the air like flakes of snow on a winter's day, and attacked everything green or succulent with a voracity and despatch destructive to the hopes of the agriculturalists."

They are described as reducing the Mormons of Salt Lake, during that year, to a simpler diet than that of John the Baptist, for the people had to fall back on the locusts without the honey; and they caused a good deal of suffering in the then Territories of Kansas, Nebraska and Minnesota. The Summer of 1855, like that of 1874, was exceedingly dry—the driest in fact that had been known for ten years.

In 1856 they again made their appearance in parts of Utah, California and Texas, but in diminished numbers. In Minnesota, however,* and in West and Northwest Iowa their ravages during this year seem to have been greater.

In 1857 we hear of them again in various parts of the Northwest† and around the Assiniboine settlement in Manitoba,‡ and they destroyed the entire crop of a region of country extending from the base of the third plateau to the Gulf of Mexico, 150 miles in length, and about 80 in breadth, including the entire valley of the Gaudaloupe, and much of the territory watered by the Colorado and San Antonio rivers. Throughout this whole area of 12,000 square miles every green thing cultivated by man was consumed, and how much further northwest the ravages extended is not known.‖ They reached as far East as Central Iowa.§

It is probable that part of the injury reported in 1856 and 1857 east of the Rocky Mountains was caused by the progeny from the immense swarms that swept over the country in 1855; and it is quite likely that some of them reached Missouri, for Mr. H. B. Palmer, of Hartville, has related to me how, about 1857, these insects passed through a portion of Wright county, from N. to S., stripping everything on their way.

* Rep. of Dept. of Agr. 1863, p. 36.

† Walsh's Ills. Ent. Rep. pp. 92-3: *Prairie Farmer*, April 25, 1868.

‡ *Canada Farmer* Aug. 15, 1874.

‖ Rev. E, Fontaine, *loc. cit.*

§ *Prairie Farmer*. April 25, 1868.

In 1860, as several Kansans have informed me, these locusts came and did much damage around Topeka, remaining a few days and leaving the last of August. This must have been a limited and rather local swarm.

In 1864 we again hear of locust invasions into Manitoba, Minnesota, and around Sioux City, Iowa, and their eggs hatched and the young did much damage the following year, 1865. In Colorado one of the most destructive visitations ever known there come in 1864 from the northwest, doing much damage, as did the progeny in 1865.

The year 1866 was another marked locust year, and the first, since that of 1855, in which the damage was sufficiently great and widespread to attract national attention. The insects swarmed over the Northwest and did great damage in Kansas, Nebraska, and Northeastern Texas, and invaded the western counties of Missouri very much as they did the past year. They came, however, about a month later than in 1874. They were often so thick that trains were seriously delayed on account of the immense numbers crushed on the track. Mr. Walsh has published a full record of this invasion in the Report already cited.*

In 1867 the progeny of those which fell upon the country the previous year did more or less damage, which was extensively reported during the early part of the growing season. Later in the season, however, fresh swarms came from the Rocky Mountain region and fell upon the fertile plains of the Mississippi Valley. Thus there were two fresh invasions, the one following the other, in the years 1866 and 1867; an occurrence which is quite exceptional, and to which the immense damage done during the latter year is, in great part, attributable. Mr. Walsh (*loc. cit.*) has given us, at great pains, a pretty full record of the doings of locusts in 1867, and from said record he makes it quite clear that the invasion of 1866 was followed in 1867 by a fresh, though less extensive one, direct from the Rocky Mountain region. I may add that a number of scraps and records of the insect's doings during those two years, other than those he has brought together, bear out his deductions. The locusts also fell upon Utah in immense swarms in 1867.

During the subsequent years of 1868 and 1869 we hear more or less of the remnants of these two vast swarms from the mountain region, and of their injury in the Mississippi Valley; but their numbers are always diminishing and their enemies increasing, so that during the latter year not a healthy individual was to be found, and in 1870

*First Annual Rep. as Acting State Ent. of Ills., pp. 83-4 (1868).

the race had about vanished from the invaded country—at least from its more eastern portions. I shall here bring together a few items and communications that will serve to continue the chronological history of the pest during these two years; confining the extracts to those cases where I have, in each instance, been able to verify, by specimens, the species referred to, as the genuine *spretus*.

In passing over into Kansas, the corn for a few miles was of a splendid appearance and rapidly maturing, but we soon came into the grasshopper country, where corn, by the thousands of acres, was stripped as clean as a field of bean poles, and entirely covered. The gardens had been completely denuded of all vegetables, and all that were used west of Fort Riley were carried from Leavenworth and further east. In returning through Northern Missouri, we found better prospects for all the crops; at Cameron Station we were shown stalks of corn sixteen feet high, heavily eared, as a sample ot many fields.—[H. D. Emery, in *Prairie Farmer*, Fall of 1868.

On Saturday, the 8th of August, the grasshoppers returned. During the night of the 7th, a strong wind commenced blowing from the northwest, which steadily continued during the next day. As early as nine o'clock A. M., large numbers of grasshoppers could be seen flying very high up; at about three o'clock P. M., the wind ceased to blow so strong although a good breeze was kept up. The grasshoppers commenced lighting, which they did in fearful numbers, in many places bending the tops of the corn-stalks on which they settled, and commenced their work of destruction. They are yet with us, and have already injured the corn crop, in many fields, much. All the early corn is too far advanced to receive any damage from them; but much of the corn crop is late because of the work of the grasshoppers hatched out here last Spring. This late crop will be much injured from the fact that it is just tasseling and shooting, and the pesky things appear to have a great liking for the tender silks and shucks on the ends of the just forming ears. With the silk eaten off, and the tassel much injured, fears are entertained that inferior ears will be formed. * * * —[S. H. K., Page county, Iowa, *ibid*, Aug. 10, 1868.

On Saturday, the 7th, in the afternoon, the "red-legged" locusts began "to pour into" this region of country, and they have been as industrious as "circumstances would permit." The cabbage, potato-vines, beets, onion-tops, and other vegetables were "pressed into service" in a short space of time. Some of my peaches are stripped of leaves; other trees only in part. The apple trees and Kirtland raspberry canes were denuded of their foliage; they even devoured the leaves of the walnut and other forest trees. Many of the weeds indigeneous to the country shared the same fate as the tender vegetables. The cherry and some seedlings of the wild cherry tree of Pennsylvania are exempt from their attacks. The foliage of the hickory appears to be a favorite dish with them.

The grape vine leaves have not escaped entirely, but Concord, Rebecca, Diana and some other varieties appear to be preferred to Clinton, Franklin and that more excellent Isabella, together with some other kinds. My young pears have been so far uninjured, but the trouble is that the ground in certain spots is literally covered with them. On Sunday, there were millions of them that made an effort to leave, but a Southeasterly wind prevented them, and they lit on the ground again.

They have, as yet, done very little damage to the blackberry plants. The rare kinds of this region that I am testing, such as the Missouri Mammoth, Wilson and Kittatiny, I covered with prairie hay, which being old they will not eat while there is anything green and tender. They do not appear to be devotedly attached to the Doolittle raspberry, as but few canes are yet leafless. On Sunday night we had a heavy rain, accompanied with thunder and lightning, which will prevent them from starting in large numbers this morning. They are evidently bound for the south. A great many left this forenoon for that direction. Many would rise a few rods in the air, but again return. They have denuded thousands of acres of corn in this region, but the extent of damage done at a distance from here I have not yet learned.—[A. M. BURNS, Riley county, Kansas, *ibid*, Aug. 22, 1868.

We have many grasshoppers. When they are small they seem most destructive. Early in the season they stripped oats and wheat indiscriminately; now they work on the wheat principally. Some wheat-fields are entirely destroyed by them, and on other fields they are eating off all the blades and youngest shoots. They have commenced on the corn. Some few are now getting their wings. Enclosed I send you specimens. A great many were hatched out last week, and millions were killed all along by heavy rains and some few by birds, etc.—[Extract from a private letter from Uriah Bruner, Omaha, Nebraska, June 8, 1868.

Enclosed find grasshoppers. The two with strings attached have parasites on their wings, and it is asserted by many that thousands have been killed by those lice. The grasshoppers are leaving about as fast as they can fly, and some are coming from other parts. We have less now than we had some time ago. Wheat and some or most kinds of garden vegetables the grasshoppers devour as fast as they can, while prairie grass, oats, etc., though they are just as plenty on, they seem to eat a great deal less of, probably not more than is necessary to subsist them.—[Letter extract from same, June 19, 1868.

The history of these grasshoppers, as far as it relates to this part of the country, is as follows: About the last of September, 1866, they made their appearance for the first time, so far as I know, in this part of the country. They came in millions from the south, southwest and west, and were so numerous as to almost darken the sun: in other words, the heavens seemed from about ten in the morning till three in the afternoon to be filled with them. They lit, ate up cabbages, Fall wheat and nearly destroyed many meadows. They cohabited, and shortly after deposited their eggs in the ground in countless millions. In the Spring the eggs hatched, and after they had obtained the full size they rose in the air and were carried away to other parts.

In 1867 they came again and deposited their eggs in the Fall, and the specimens I send are from them. The number of eggs deposited last Fall was not as great as in the Fall of 1866.

The grasshoppers hatched here injure our Spring crops and then leave, to be followed in the Fall by others from the far West to prey upon our fall vegetation and deposit their eggs for another crop. One farmer told me a few days ago that the damage which he sustained from them last year could not have been less than $1,500. Last Fall I put in some Fall wheat which was entirely consumed by them. * * *

I am of the opinion that stirring the ground in the Fall exposed the eggs to the action of the frost and destroyed many of them, as but few were seen there this Spring. The hogs in the Spring root the ground over for their eggs and destroy many of them. * * * —[Letter extract from Stephen Blanchard, Oregon, Holt county, Missouri, July 13, 1868.

* * This morning and some portion of yesterday the wind was in the east, but this morning soon changed to the west, and we thought about 10 o'clock that it would rain, but about noon, or perhaps a little before, the wind changed to the north, and about 2 o'clock the grasshoppers began to fall about as fast as the flakes of snow fall, until the ground was *literally covered with them.*—[Letter extract from same, Aug. 10, 1868.

My corn has been quite badly injured by the "Western Locust." I have a small orchard of about 200 trees that have been greatly injured.

My trees set out this Spring (about 50) are as naked of leaves as they should be in February next. The trees set out a year ago are badly injured, and so are those set out three years ago. If you will send me by mail a little of the article which you recommend I will most gladly try it, and will give you the results. They have been coupling for increase for several days past. They are not now as numerous as they have been, and if they leave before they deposit their eggs in the ground for Spring hatching we may get rid of them.

It may be also that as it is so much earlier than heretofore when they came, that their eggs might hatch this Fall. In this case they will not do us much injury in the Spring for the reason that the Winter would kill them.—[Letter extract from same, Aug. 24, 1868.

I send you herewith, specimens of the Red-legged Locust, which frequently overruns our extreme western regions, but appeared *here* for the first time last Fall. They are quite as ruinous to us as Yankee carpet-baggers and scallawags! I will give you a brief sketch of them also—the *insect* Locusts, not the others!—[Extract from a private letter from the late Thos. Affleck, Brenham, Washington county, Texas, July 20, 1868.

Those hatched from eggs which were deposited after migrating to this country, so distant from their natural habitat, *do not copulate before their departure hence.* That you may record as a fact, general, I think, if not universal.—[Letter extract from same, Aug. 22, 1868.

In the Appendix will be found a letter from Mr. Affleck giving a more full and interesting account of his experience with this pest during 1868. That the insect was more or less injurious, in 1868, throughout the region invaded the two previous years is proved from various records of their hatching out, and their injuries around Salt Lake City, Utah, and by the fact that the Red River settlement appealed to the Canadian Government for aid, on account of their devastations during that year. They are reported as having been quite numerous in Andrew, Cedar, Clinton, Daviess, Gentry, Jackson, Nodaway in our own State, by the different correspondents who replied to my circular. They also attracted some attention in Kansas during the fore part of August, and during the preceding month in Iowa and Minnesota.*

In 1869 there were still some remnants left of the 1867 invasion. I received some from Leavenworth, Kansas, sent in a tin box, and in reaching me there was but one left, which, having eaten up the others, was master of the situation. They hatched out in countless numbers from the 20th to 24th of March, in Holt county, Mo.,† and were destructive east of Nemaha county, Kansas; but the following items from the *Prairie Farmer* "Record of the Season," will indicate how more and more impotent they became :

Great numbers of the "Red-Legged Locust"—grasshoppers—have hatched out this Spring, but have done very little harm thus far, their ravages being almost wholly confined to the more tender garden vegetables.—[C. W. D., Saline county, Kansas, June 22, 1869.

The "hateful grasshoppers" are very bad in sandy districts, and, when full fledged, they will visit every farmer, and take their portion.—[C., Denver, Col., July 6, 1869.

Grasshoppers all left as soon as they could fly, and there has no new crop come in since. Apples were not injured here; peaches were, to some extent, but there will be a fair yield. Wild fruits of all kinds are abundant.—[J. W. O., Brown county, Kansas, August 16, 1869.

The grasshoppers hatched out here last Spring, but did very little damage; they all left as soon as they could fly, and I hope it will be long before they pay us another visit. There is not much fruit raised here yet, but what there is is pretty good.—[W. S. S., Page county, Iowa, September 4, 1869.

The following letter, communicated to me, August 27, 1869, by S. K. Faulkner, M. D., of Whitesville, Andrew county, Missouri, will show that they were also lingering in our own State:

I did not answer your letter requesting more specimens of the Colorado Grasshoppers with parasites, because they had left us, and now there is not one to be found. We had quite a stock of grasshopper eggs left us last Fall, which hatched, and in the timbered section and where the ground was smooth and hard, as "sod" or prairie that was plowed in the previous June, and not afterward plowed, they destroyed most of the wheat. But deep plowing in the Spring or late in Autumn puts them down, at least delayed them, and I think they never hatch.

* *Am. Entomologist* I, p. 74.

† W. L., in *Journal of Agr.*, St. Louis, Apr. 17, 1869.

Our own stock was bad enough, but on the 18th of June we received a large addition of flying ones from the South, which in some places took half of the corn, although they left on the 23d of June, staying less than five days. They came with a strong south wind, and while here the north wind blew, and if they were disturbed they would work a little South; but on the 23d, at 11 A. M., the south wind blew, and they rose simultaneously, and most of them left us; but our original stock not being able to fly, remained.

My experience is, that they like vegetables, in about the following order: Cabbage, turnips, dog fennel and burdock, tender apple and pear leaves, especially if close to the ground, as on young grafts. There are few nurserymen here who will set apple grafts if we have eggs in the ground. Then wheat, corn, oats—if hard, preferred; but they do most damage to oats by dropping the grain on the ground in cutting it off. They relish grapes about the same as oats; but the hydrocyanic acid in peach leaves is too much for them, and I have not seen one touched.

As I am glad to see you doing so good a work so well, if I can furnish you any information it will give me pleasure.

During this year, 1869, and the two following years, as will be seen from what is said further on under the head of "injuries by other non-migratory species," many of the common locusts of the country were unusually numerous and destructive; and the reports of their injuries must not be confounded with those of the Rocky Mountain species. Mr. Cyrus Thomas (*Am. Ent.* II, p. 82,) reports finding this species, in June, 1869, around St. Joseph, Mo. He says: "We arrived very early in the morning, and then they appeared to be somewhat torpid; yet when those in the grass were disturbed by the hogs, which were feeding upon them, they hopped about quite briskly. Swarms of them, as I was informed, had been flying over that section for a week previous to our arrival."

In 1870, what was probably this last species, swept down upon the country around Algona, Iowa, and in 1871 the progeny "hatched by myriads till after the first of June," and left about the first of July.* In parts of Utah and Colorado their injuries were also reported during this year.

In 1872 again they did some harm in parts of Kansas, for Mr. Albert Cooper, of Beloit, Kans., wrote me (September 1, 1872): "They came down upon us a few days ago, and are now eating up everything green." Mr. J. D. Putnam, who spent the Summer of 1872 in the Rocky Mountains, also wrote me "that *spretus* was quite numerous in the valley of the Troublesome River."

THE INVASION OF 1873.

During the years of 1873 and 1874, we have had a repetition, in a great measure, of the years 1866 and 1867. The invasion of 1873 was pretty general over a strip of country running from the northern parts of Colorado and southern parts of Wyoming, through Nebraska and Dakota, to the southwestern counties of Minnesota, and northwestern

* *Western Rural*, Chicago, September 26, 1874.

[Fig. 31.]


Map of North America, illustrating the country east of the Rocky Mountains subject to the Ravages of the Rocky Mountain Locust — Prepared by C. V. Riley.
Explanations.
Country subject to its ravages.
Country ravaged in 1874, and which suffered most.
Invaded in 1874 but suffering less on account of being sparsely settled.
AMERICA
CANADA
BRITISH AMERICA
BRITISH COLUMBIA
MAINE
N.H.
VERMONT
MASS.
CONN.
NEW YORK
N. JERSEY
PENNSYLVANIA
MARYLAND
VIRGINIA
W. VA.
N. CAROLINA
SOUTH CAROLINA
GEORGIA
FLORIDA
OHIO
MICHIGAN
INDIANA
ILLINOIS
KENTUCKY
TENNESSEE
ALABAMA
MISSISSIPPI
LOUISIANA
ARKANSAS
MISSOURI
WISCONSIN
MINNESOTA
IOWA
KANSAS
NEBRASKA
DAKOTA
INDIAN TY.
TEXAS
NEW MEXICO
COLORADO
WYOMING
MONTANA
IDAHO
UTAH
ARIZONA
NEVADA
OREGON
WASHINGTON
CALIFORNIA
MEXICO
Salt Lake City
Little Rock
St. Paul
Des Moines
San Francisco
Sierra Nevada

counties of Iowa—the injury being most felt in the last two more thickly settled States. The insects poured in upon this country during the Summer and laid their eggs in all the more eastern portions reached. The cry of distress that went up from the afflicted people of Minnesota in the Fall of that year is still fresh in mind, and the pioneers of West Iowa had to suffer, in addition to the locust devastations, severe damage from a terrific tornado. Great ravages were also committed by locusts in Southern California during the same year.

THE INVASION OF 1874.

We now come to the Locust visitation of 1874, which will long be remembered as more disastrous, and as causing more distress and destitution than any of its predecessors. The calamity was national in its character, and the suffering in the ravaged districts would have been great, and death and famine the consequence, had it not been for the sympathy of the whole country and the energetic measures taken to relieve the afflicted people—a sympathy begetting a generosity which proved equal to the occasion, as it did in the case of the great Chicago fire, and which will ever redound to the glory of our free Republic, and of our Union.

From a very large number of data, culled from every available source, I have prepared the accompanying map, which will at a glance illustrate the country liable to be overrun by this Rocky Mountain scourge, and more especially the territory in the United States east of the mountains, visited in 1874. This last will be seen to embrace the entire States of Colorado, Nebraska and Kansas, and portions of Wyoming, Dakota, Minnesota, Iowa, Missouri, New Mexico, Indian Territory and Texas. The heavy, dark lines indicate the area over which the greatest injury was done; the dotted lines the area which suffered less, because more sparsely inhabited; and the fine lines the area which was more or less overrun by them. The insects were doubtless as numerous in the northwestern parts of Wyoming and Dakota, and in Montana, for, in fact, they breed there; but the country is for the most part so barren and so thinly settled that the reports are very meagre. The damage inflicted in this territory cannot fall far short of fifty millions dollars. That much of the damage resulted from the progeny of the swarms of 1873, which, hatching in the country already indicated, as invaded during that year, ravaged the crops of the country where they hatched, and eventually spread to the southeast, the records abundantly prove; but there was likewise a fresh invasion direct from the mountain region, which added to that of 1873, rendered the year 1874 so memorable.

In order to present a more intelligible account of this 1874 invasion, it will be best to treat it briefly in connection with each State and Territory which suffered from it.

From New Mexico, Texas and Indian Territory the reports that have come to my notice are meagre; yet they are sufficient, in connection with those published by the Department of Agriculture, to show that the territory indicated in my map was more or less visited. In Texas, they were more particularly injurious in Cooke, Belknap, Blanco, Blandera, DeWitt, Palo Pinto, Gillespie, Medina, Kendall, and San Sabo counties.

Missouri—Fully aware of the importance of a complete and reliable record of the Locust invasion of our own State, not only as a matter of history, but as a guide for the future, I have taken some pains to make the record as complete as possible. In order to do so, I sent out the following questions to correspondents in each county—the same, in fact, to whom I addressed the Chinch Bug circular:

1. Did the Locust appear at all in your locality or in your county the past Summer or Fall?

2. If so, give the exact date at which they first appeared, and, as near as may be, the direction from which they came, and the direction and force of the wind at the time.

3. State, as near as may be, the prevailing direction in which they flew or traveled, and whether the direction was much altered or influenced by the winds. Also, whether different swarms came at different times from different directions.

4. How long did they stay?

5. What plants or crops were most injured by them?

6. What plants or crops more particularly escaped their ravages?

7. Did the locusts lay eggs; and if so, what positions did they prefer, as sward, stubble, roadways, ploughed, high or low ground, etc.?

8. Were any of the eggs noticed to hatch during the protracted and mild Fall weather?

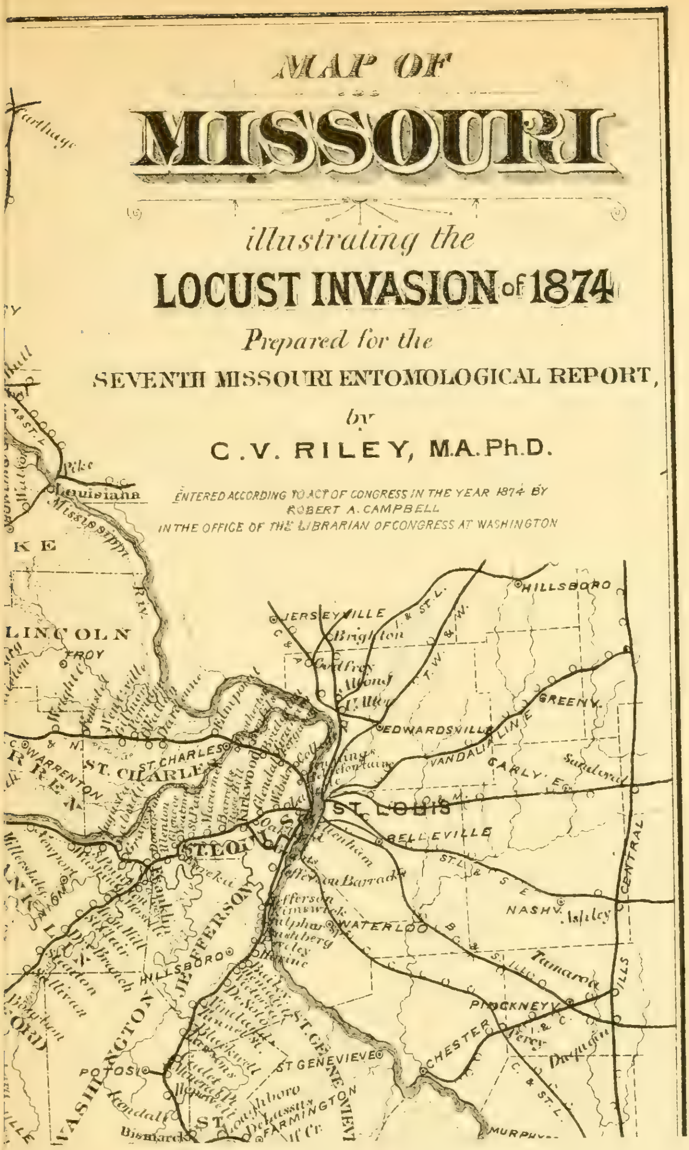
9. What are your recollections of former visitations, with reference to these questions? And what has been the damage resulting the succeeding year of such visitations, from the young hatched on the ground?

10. Give an estimate of the amount of damage caused by them in your county.

11. What means have been adopted to prevent their injuries or to destroy them?

12. *State more particularly, if locusts invaded your county, the precise eastern limit which they reached.*

Being firmly of the opinion that these insects would never do any serious damage east of a line drawn, at a rough estimate, along 17° west from Washington, and knowing that we could only judge of the


MAP OF
MISSOURI
illustrating the
LOCUST INVASION of 1874
Prepared for the
SEVENTH MISSOURI ENTOMOLOGICAL REPORT,
by
C.V. RILEY, M.A. Ph.D.
ENTERED ACCORDING TO ACT OF CONGRESS IN THE YEAR 1874 BY
ROBERT A. CAMPBELL
IN THE OFFICE OF THE LIBRARIAN OF CONGRESS AT WASHINGTON
Louisiana
Pike
Mississippi
LINCOLN
TROY
JERSEYVILLE
Brighton
HILLSBORO
EDWARDSVILLE
GREENV.
VANDALIA LINE
ST. CHARLES
WARRENTON
ST. LOUIS
BELLEVILLE
NASHV.
Ashley
WATERLOO
JEFFERSON
HILLSBORO
PINCKNEYV.
CHESTER
ST GENEVIEVE
POTOSI
FARMINGTON
Bismarck
CENTRAL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EXPLANATIONS.
THE RULED LINES indicate the counties invaded by locusts in 1874 and the direction in which they came.
THE + indicates the counties invaded in 1866.
NODAWAY
GENTRY
HARRISON
MERCER
PUTNAM
SULLIVAN
ADAIR
SCOTLAND
KNOX
CARROLL
CHARITON
MONROE
PIKE
LINCOLN
SALINE
HOWARD
JOHNSON
MORGAN
BENTON
BATES
HICKORY
CAMDEN
MILLER
MARIES
CRAWFORD
WASHINGTON
CEDAR
POLK
DENT
BARTON
DADE
GREENE
TEXAS
SHANNON
REYNOLDS
CARTER
DOUGLAS
CHRISTIAN
OZARK
OREGON
RIPLEY
BUTLER
BARRY
McDONALD
CAPE GIRARDEAU
ST. LOUIS
ST. CHARLES
QUINCY
C. JUEHNE LITH. ST. LOUIS

future by the past, I drew particular attention to the last question, as one not answerable from my own individual observation, as most of the others are. The replies to the above questions have been very full, for which fact I must again thank the gentlemen mentioned on pp. 51–2, *ante*. From these detailed reports, I have constructed the accompanying map* which indicates, 1st, the counties invaded in 1866, marked with a small cross (+); 2nd, those invaded in 1874, and the eastern limit reached, marked by ruled lines; 3d, the general direction from which the insects came, marked by the direction of the lines and by arrows. The answers to the different questions have been properly filed and arranged by counties, and will be preserved. They are too voluminous to publish, and it is sufficient here to give a summary of them, numbered to correspond with the questions.

1—This question is sufficiently answered on the map, from which it will be seen that 35 of our western counties were invaded, and that they reached farthest into the State in Benton and Pettis.

2—The general direction from which they came was from the northwest, the reports showing remarkable agreement in this respect. The greatest deviation from this course occurred in the more eastern or last counties visited, when the army became pretty well thinned out and demoralized, and flew about with less uniformity, being more governed by the wind. The dates at which they are reported from the different counties are interesting, and show that the insects advanced at an average rate of not more than three miles a day. That they travel at a far greater speed, every one who has witnessed their migrations is aware, and this low average rate is due to the fact that they fly only during the heat of the day and on certain days when the wind and weather are favorable, and to the further fact that the insects were no longer as vigorous and numerous as they had been in the country to the west. Another interesting fact is deducible from the returns, viz.: that the rate of advance was greater in the counties first invaded than those last reached—a fact indicating that the insects were getting more and more exhausted and less desirous of flight the farther east they came. They reached Holt county on the 8th of August, and all the counties on the same line, north and south, from Worth to McDonald, were reached during the latter part of the same month. They then continued to make short flights, and finally reached their extreme eastern limit toward the last of September.

3—The correspondents do not agree as to whether the wind has

* Where the map does not accompany this page it will be found in front of the Volume.

much influence on their flight; but the majority of the reports show that, as is the nature of the insect in other States, it only flew in dense swarms when the wind was from the northwest.

4—In most of the counties invaded, the locusts stayed till frost; i. e., from their first appearance till frost, swarms came and left, so that there were almost always some of them about. In some of the last counties invaded, they were observed for only a few days, and in all, their numbers diminished more and more through natural or unnatural death, until Jack Frost vetoed the hopping and kicking of the very last stragglers.

5—On account of the long continued drouth, and the ravages of the Chinch Bug, but little green food was left for the locusts to destroy. This, however, they took, showing no mercy. Corn was already too hard in most of the invaded counties to be damaged; but they stripped every green blade, and often the husks, when not already killed by the Chich Bug. Fall wheat and rye were eaten as fast as they came out of the ground, and the sowing of these grains was delayed on that account. Oats were taken, but as a rule only after wheat and rye. Clover and timothy shared the same fate, and, in fact all the grasses suffered. Most garden vegetables were destroyed. The tops of peanuts, buckwheat and beans were also to their taste, and they were particularly partial to hemp. Apple, pear and peach leaves were not amiss, and the green peaches were devoured, with the exception of the stones which were left hanging to the trees. Green apples were refused. Grapes were cut off from the vines, but not eaten. Tobacco was eaten in many instances, but they did not seem to enjoy it.

6—It is well known that these omnivorous creatures will devour almost anything when pushed from hunger; yet they have their likes and dislikes, and their conduct in Missouri, so far as regards the latter, as condensed from the reports, may be thus stated: Plants belonging to the Nightshade Family (*Solanaceæ*) generally escaped their ravages; the tops of potatoes and tomatoes were not eaten. Sweet potatoes, parsnips, castor-beans, butter-beans, carrots, celery and the tops of beets were not molested. They did no damage to broom-corn or sorghum. Tobacco was in most cases not eaten, and if eaten, it is reported as killing the locusts. Prairie grass, wild weeds and the leaves of most forest trees were left uninjured. Plants growing in wet places, or in the shade of trees, hills, etc., mostly escaped injury.

7—In most of the counties invaded, the insects are reported as having laid eggs; and in some localities the eggs were so numerous as to whiten the surface wherever the ground was ploughed and they were exposed to the bleaching and cleansing effects of sun and rain. All the reports agree that low and moist ground was avoided.

8—In most counties, even in the northern ones, some of the earlier eggs hatched, especially those laid on hill-sides and other high ground exposed to the rays of the sun. The young hoppers attained a size of $\frac{1}{4}$ to $\frac{1}{2}$ of an inch, and were active during the middle of the day, even into December. These young hoppers disappear and seek Winter shelter; but it is doubtful whether many, if any, survive the Winter.

9—From the accounts received in answer to this question, it appears that in 1866 the locusts invaded pretty much the same counties, the farthest point reached to the eastward being the western portion of Benton county. As the map indicates, they reached somewhat further east in the northern part of the State than in 1874, but not so far in the southern counties, there being none recorded in Polk and Lawrence. Yet imaginary lines, indicating the average eastern limits of their advance in either year would run a little to the east of Warrensburg and Clinton in Johnson and Henry counties, and not more than a dozen miles apart. They came a month later in 1873 than in 1874, and were moving from about the first of September to the end of October. The direction of their flight and progress was precisely as the past year, i. e., from the northwest. They deposited large numbers of eggs which—for the most part—hatched in the Spring of 1867. The young hoppers did much damage in many localities in the Spring of this year, destroying the wheat, corn, grasses and vegetables by stripping off the leaves and leaving only the bare stalk standing. They also attacked the oats, biting the stalks and causing the grain to drop. They fed in large bodies, traveling together, and thus devastating the crops in strips and sections, leaving the intermediate fields untouched. But taking the reports of all the counties, comparatively little damage was done by these young hoppers—much less than was anticipated and seemingly warranted by the large numbers which hatched. They were attacked by parasites and diminished rapidly in numbers; and those which acquired wings, in the early part of July, generally left their place of birth, flying in all directions, but principally in the opposite direction to that in which they had come the previous Fall. They laid no eggs and were gradually lost sight of the latter part of the growing season.

10—The insects came too late last year to do very great injury. Everything green had about disappeared on account of the continued drouth and Chinch Bug. Wheat had been harvested and was therefore uninjured; corn was too dry and hard to suit their taste. The damage was chiefly done to the young wheat, which they made a clean sweep of in many localities—chiefly in the southern counties, where it was already sown. Pastures were injured so as to oblige very early feeding of stock. The principal damage was done to garden truck, and tender trees and shrubs; and compared to the injury of the Chinch Bug the aggregate damage by locusts was slight; while some of my correspondents considered these last a benefit on account of the abundant and fattening food they supplied to poultry and hogs.

11—With the exception of Fall plowing and collecting and feeding the insects to hogs, no remedies or attempts to destroy the pests are reported.

12—The answers to this question are summed up on the map.

Kansas—While the injuries caused by the invasion of 1874 was comparitively slight in Missouri it was very great in Kansas. The locusts swept down upon that State in overwhelming hordes from the plains of Colorado on the west, and the fields of Nebraska on the north, in many instances clearing off all traces of vegetation in a few hours. The corn crop, not being as advanced as it was in our own State upon their advent, was ruined by them. I have newspaper and private reports of the appearance of the insects in all the counties, except Clarke, Comanche, Gove, Doniphan, Graham, Greenwood, Harper, Hodgeman, Kiowa, Neosho, Ness, Pratt, Sumner, Stafford, Trego and Wallace. Most of these counties are yet unorganized and do not exist, except upon the maps, the population being very limited and of a transient character. They were undoubtedly overrun like the rest, for Mr. Chas. S. Davis, of Junction City, who sent out postal-card queries over the State, informs me that he has reports from Doniphan, Comanche, Greenwood, Neosho and Sumner; and Mr. Alfred Gray, who has published full returns in his excellent report for 1874, as Secretary of the State Board of Agriculture, informs me that no county was free from visitation. He writes: "I have consulted with several reliable gentlemen concerning the appearance in the unorganized portion of the State, and find that the visitation was general. The representative from Ford county, Mr. Wright, says that south of his locality, in the Indian Territory, they appeared in immense clouds and would dip down at long intervals, and would as suddenly leave."

From the monthly returns published by Mr. Gray, it appears that 34 counties reported products enough to enable them to bridge over the Winter. Thirty counties reported 1,842 families, aggregating 9,154 persons reduced to destitution. The press of the country has been full of accounts of the destitution and suffering which this visitation entailed on the people of our sister State, and the agents of relief societies have appealed with effect to the generosity of the people throughout the land. The accounts of the suffering and distress have been very conflicting, and the truth doubtless lies between the heart-rending, sensational compositions, and those which, prompted by State pride or real estate interest, go to the other extreme, and underate the real distress. The following from Mr. Gray's Report, undoubtedly gives a calm and truthful statement:

About the 25th of July one of those periodical, calamitous visitations to which the trans-Mississippi States are liable once in from eight to ten years, made its appearance in northern and northwestern Kansas—the Grasshopper or Locust. The air was filled and the fields and trees were completely covered with these voracious trespassers. At one time the total destruction of every green thing seemed imminent. Their course was in a southerly and southeasterly direction, and before the close of August the swarming hosts were enveloping the whole State. The visitation was so sudden that the people of the State became panic-stricken. In the western counties—where immigration for the last two years had been very heavy, and where the chief dependence of new settlers was corn, potatoes and garden vegetables—the calamity fell with terrible force. Starvation or emigration seemed inevitable unless aid should be furnished.

Again, Gov. Osborne says in his message to the Leglslature, convened in extra session by special proclamation to take action regarding the suffering:

Since issuing my proclamation convening the Legislature, an extensive correspondence has been carried on with the people, especially in the western counties, and every effort has been made by the executive office, as well as by the officers of the State Board of Agriculture, to obtain reliable statistics in regard to the condition of the people. The result of this inquiry shows that while Kansas as a State has an abundance of breadstuffs—much more than is needed to feed all her people—that that portion of the State which has been almost entirely populated during the past eighteen months, will suffer for want of the necessities of life unless provision is made for its relief.

From information now in my possession, it appears that the sections of the State for which relief should be provided by legislation are confined to the counties west of the sixth principal meridian. The counties most seriously affected, and for which the needed relief cannot be afforded by the local authorities, are Norton, Rooks, Ellis, Russell, Osborne, Phillips, Smith, McPherson, Rice, Barton, Reno, Barbour, Edwards and Pawnee; while the counties of Harvey, Jewell, Ellsworth, Sedgwick, Sumner, and possibly some others, may require more or less assistance. Of these, the greatest destitution seems to prevail in the extreme northwest, embracing Norton, Phillips, Rooks, Osborne and Smith counties, and the unorganized counties lying west, where immediate aid seems necessary.

At the special session, townships in the destitute counties were authorized to issue bonds to the amount of $50,000, but the act was subsequently declared unconstitutional by the Attorney-General, so that no bonds can be sold. This source of relief was therefore of no avail, and the regular Legislature was subsequently strongly petitioned and urged to afford relief by direct appropriation. Its action will ever redound to its discredit and to that of the State. After the whole country had, by sanction of its authorities, been canvassed and importuned for aid and relief, it was still evident as Spring approached that much assistance was needed in the frontier counties, and that, without such assistance, the farmers in many counties would be unable to obtain seed to put in their crops or to carry on their legitimate farm operations. Yet in face of the constant appeals from thousands of sufferers, supplemented by two special messages from the Governor, in one of which he says: "I tremble to anticipate the judgment of mankind upon a commonwealth which, having encouraged appeals to the charity of the people of the whole country, steadfastly refuses to relieve a single want at the expense of its own treasury"—the Legislature finally adjourned without making any appropriation whatever. Yet there was abundant means in the treasury and the appropriations made for other purposes exceed half a million dollars. The ill repute which this neglect of her Legislature in the hour of need will bring upon the State will stick to her like the shirt of Nessus.

The following extracts from my private correspondence will indicate the periods at which the insects reached different parts of the State:

My interest in the cause in which you labor is my excuse for addressing you at this time. By virtue of your office you are public property, and the people of Kansas feel as if you belonged to us as well as Missouri. The main subject upon which I wish to write you is the "grasshoppers." Swarms of grasshoppers have been appearing in different parts of the State since the 15th of July. It is only within ten days that they have appeared in this immediate vicinity, and from what observation I have been able to make I cannot see that they have laid any eggs yet. They eat as voraciously as any I ever heard of. But for this fact, I would think they might be a brood hatched somewhere on the plains between here and the mountains, and that they will not breed. I understand that the only method of determining the difference between the barren brood hatched in the low lands and the swarms from the mountains is in the time they make their flight. In the Spring of 1869, when I came to this place, I watched the Spring brood hatch, and they all left as early as the middle of June. * * *—[Robert Milliken, Emporia, Lyon county, Kansas, Aug. 10, 1874.

I send you by mail a specimen of the devouring host. On Sunday evening, July 26th, they came down upon us by millions and soon cleaned our corn-fields and orchards, and then stripped the trees of their foliage. One week ago the bulk of these left, and we felt relieved of our fears that they would interfere with wheat sowing; but yesterday the sky was darkened with a new installment. There is no corn left even for seed in this county, and they are ruining the orchards. I send you some twigs. Often the trunk is girdled when they are 3 inches through. Nothing comes amiss to them, though they seem to have some preference for food. Box Elder does not seem to be palatable to them, or Black Walnut, still they will eat them, and large trees are stripped of leaves. Tobacco they seem to like, and you can see bunches big as your fist fighting and struggling to get a taste of some old quid that has been thrown in the road. To attempt to give any idea of the destruction of these plagues is useless, for the general public will not believe one-half the truth, but set us down as liars.—[H. L. Jones, Salina, Saline county, Kansas, Aug. 13, 1874.

I send you a few specimens of our "hoppers." They have destroyed the entire corn crops of Central and Western Kansas and left thousands of people in absolute destitution. They have tarried with us longer this year than usual, having been detained by adverse winds from making their usual annual southerly migration. They do not usually trouble us unless stopped in their course south by currents counter to the direction of their flight.—[N. B. Truland, Cawker City, Mitchell county, Kans.. Aug. 11, 1874.

On Saturday the grasshoppers came down upon us here at Ottawa. They had been for some days to the north and east of us, and on Saturday a north wind brought them. They are in and upon everything, thick as bees in swarming time. I send you some specimens. Are they *Caloptenus spretus?* I presume they are, without doubt. Yet I notice that many of them have the wing covers much less than $\frac{1}{3}$ longer than the abdomen; but I believe all males have the little notch in the ventral segment. Will they probably remain here and deposit their eggs, or may we expect to see them move off? I have not seen any pairing yet.—[Wm. Wheeler, Ottawa, Franklin county, Kansas, Aug. 24, 1874.

As there prevails a belief that Kansas will suffer permanently from locust devastations; and as many people are deterred from migrating thither from fear of these insects, the following answer to an inquiry which I published in the New York *Tribune*, last October, may serve to measurably allay this fear.

Does the science of Entomology offer a solution to the Grasshopper question, that scourge of the trans-Missouri? I have made my arrangements to settle in Kansas or at some point in the "Far West" for the purpose of making a home, but do not relish the idea of being menaced by famine.—[Z. F. Hopkins, Jackson Co., Ill.

Just now the people of Kansas are, in many sections of that unfortunate State, greatly discouraged, and there is quite an exodus from her extensive and fertile plains, especially of the more recent settlers. Nor is the outlook encouraging, for the locusts very generally fell upon whatever in the way of food and forage had braved an unusual drouth. Yet much unnecessary alarm is manifested, and the desolation has been greatly magnified. The authorities have fully canvassed the position and find no need to ask assistance from sister States, and we may rest assured that while many of her farmers must suffer deprivation the coming Winter there will be nothing heard of the predicted famine. We should not forget that eight years ago Kansas suffered from such a locust invasion, yet the eight intervening years between the invasion of 1866 and that of the present year have been among the most propitious in her history.

The story of the Locust (*Caloptenus spretus*) is a long one, but without going into details, I can see no good reason why any one should hesitate to settle in Kansas on account of these insects. If I had any intention of settling in that State, I should choose this time of all others to do so: first, because so many of her citizens have become alarmed and are willing to sell fine homesteads at a great sacrifice; secondly, because, from the past history of these invasions, her people may reasonably expect exemption from them for a period of eight, ten, twelve or more years. Two invasions are not likely to succeed each other within two years in the same territory, and this is so well understood among the Mormons, who are apt to suffer from such devastating hosts, that they are in the habit of laying in a two years' supply of provisions—never fearing that there will be any need of a three years' supply. The people in Montana, Idaho and Nevada, expect to suffer from them about once in every seven years. The same argument, also, which would deter people from settling in Kansas would deter them from settling in the western part of Iowa, in Colorado, Nebraska, Texas, Minnesota, in short, in any of the country 500 to 550 miles east of the Rocky Mountains, from British America to Mexico; for all this vast extent of country is more or less subject to locust invasions. There are, indeed, few parts of the country not subject to periodic misfortune, either from meteorological or entomological excesses.

NEBRASKA.—Next to Kansas, this State suffered most, having been entirely overrun, as the following extract from a letter from Gov. R. W. Furnas will show: "The whole of our State, from a point, say thirty miles from the Missouri river west, has been more or less affected by 'grasshoppers.' The extreme western portion of the State was entirely devastated." They came in legions from the north and northwest, and the following extracts from correspondence will sufficiently indicate the time of appearance, which was during the last of July:

This region was visited by these grasshoppers on July 21st, and after a sojourn of ten days they departed, and with them went our corn crop for 1874. For ten long days the pests fed and fattened on our immense corn crops, and the last three or four days of their stay they deposited their eggs by the million all over the plowed ground and new breaking. In some places a small fly, and also the common black ant, have been destroying the eggs. But for every one destroyed there are probably a thousand left. It was fortunate for us that they came no sooner, as the small grain here was all ripe and they did no damage to it.—[J. W. D., Fillmore, Neb., Aug. 5, 1874.

The locusts visited us about three weeks ago from the South, and stopped about ten or twelve days with us, doing a great deal of damage to corn, garden stuffs, etc.; but I think we shall get about a one-fourth crop of corn. Don't they like onions! You could see them stand upon their heads eating into these vegetables, and they left nothing but a skin outside. I noticed upon new breaking thousands of them pairing, but I think the bulk left before depositing eggs. The wheat crop and all small grain has been good; but I believe that up the Republican Valley, in the Southwest of the State, the new settlers will have a very hard Winter, on account of the locusts.—[J. W. C. White, Lincoln, Dodge county, Nebraska, August 14, 1874.

The locusts made their appearance here about the last of July, and left on the 7th of August. The wind was blowing from the Southwest at the time of their arrival, but I think there was an upper current of wind from the North, which carried the greater part of them past, not more than one in ten (apparently) coming down. The day after their arrival the wind blew from the Northeast, and at about 10 A. M. they began to leave, a few at a time, until about 12 A. M., when they arose in a cloud, and for some hours the air was full of them, some going and some coming. After they had been here for a few days, they gathered in great numbers on the new breaking for the purpose of breeding. The result of their visit to this part of Nebraska may be summed up as follows: Corn damaged to some extent; vegetables of all kinds, except potatoes, completely destroyed; apple and pear trees stripped of foliage, and the stems of the fruit eaten, so that most of it has fallen off. In some places they have eaten the peaches entirely, nothing being left on the tree but the pit.—[Wm. Dunn, Emerson, Otoe Co., Nebraska, August 20, 1874.

The locusts came more than a month ago, and after flying backward and forward for a couple of weeks, they settled down, apparently determined to stay.—[Jno. Byfield, Red Willow, Nebraska, August 21, 1874.

A "Nebraska Relief and Aid Society" was organized to provide for the destitution caused by the visitation, and through its exertions and through legislative aid all suffering was avoided. Gov. Furnas in his message to the Legislative Assembly gives the following summary of doings, after stating that the receipts by the Aid Society amounted, up to that time, to $68,080:

Our own State, like most other portions of the country at large, especially the West, has been afflicted the past season with short crops, by reason of drouth and grasshopper devastation. While the injury has been greater than from any and all causes heretofore in the history of the Territory and State, and cannot be otherwise than discouraging, particularly to the agriculturists, there is no disposition manifested to abandon any portion of the State * * * The visitation falls on the frontier counties with particular force. They must be aided or quit the country. Aided until another year's crop is produced, the foundation is laid for a prosperous future. Aside from a natural and general principle of humanity, other good and sufficient reasons exist why these people should be aided liberally and promptly. A very large proportion of those now on our extreme borders and in need, are ex-soldiers; those who responded promptly to their country's call in the late hour of peril. * * *

Our own people in the older portion of the State, not seriously affected, have contributed liberally and promptly, both in money and in kind. All the railroads in the State, as well as those leading into it, have, with commendable liberality, extended free transportation to the State Society in aid of those in need. Generals Ord, Brisbin, Dudley and Grover, of the regular army, have rendered incalculable aid and assistance, entering with a will and zeal into the work of relief. Through the instrumentality of General Ord, the Secretary of War ordered the issue of clothing to those in need. Many portions of the older States, hearing of our misfortunes, came nobly and promptly to the relief, and very liberally. The Nebraska Patrons of Husbandry have organized a State association for purposes of relief, and not only in this, but in other States, are accomplishing very much in the matter of aid. Through the efforts of our delegation in Congress, acts for the relief of our people have passed that body. Extension of time has been given homesteaders, and a cash appropriation of $30,000 has been made with which to purchase seeds the coming Spring.

IOWA—As already stated in the chronological chapter, the Rocky Mountain Locust* invaded the northwestern counties of Iowa in the Summer of 1873, and much of the injury in 1874 resulted from their progeny. Fresh swarms came, however, in 1874, and the western counties of Algona, Calhoun, Cherokee, Clay, Dickinson, Emmett, Harrison, Humboldt, Jasper, Kossuth, Lyon, O'Brien, Osceola, Palo Alto, Pocahontas, Plymouth, Sioux, Winnebago and Woodbury, suffered more or less. East of the line indicated in my map, Iowa suffered nothing from these pests, and as the drouth was less severe than in other parts of the country, and the crops good, the distress in the ravaged counties was easily relieved.

A committee appointed to investigate the extent of devastation and of suffering in 1874, made the following cheering report to the Governor:

> We have heard, in the northwestern counties, of only a single report of eggs laid by the grasshoppers, and the pests left us too early for egg deposits; and we trust and believe they have left us for many years if not forever. The vast majority of those whom the benevolence of the people aided last year, and kept upon their farms and homesteads, have raised good crops, and with good farms and smiling faces they speak of the kind hearts who aided them in their hour of need. Now, this year, we want more aid, and must have it, to assist the settlers in Kossuth, Emmett and other sections of counties. It will take a large amount of supplies to preserve homes and make homes happy and comfortable there. Let the people with their magnificent crops and great hearts, pour out of all their abundance, and save the little farms of those who are striving to keep their little homesteads for themselves, their wives and children.

MINNESOTA—As in the case of Iowa, Minnesota was visited along her western border by these insects in 1873, and she had consequently to suffer from the young of that invasion in addition to the fresh swarms that overspread very much the same territory in 1874. The counties ravaged in 1873 were thinly settled, mostly by homesteaders with little means, and the consequent suffering was therefore very great. The value of the crops destroyed in 1873 was estimated officially:

Wheat	$2,000,000
Oats	528,000
Corn	256,000
Other crops	250,000
Total	$3,034,000

* My friend, J. M. Shaffer, in his Report for 1873, as Secretary of the State Agricultural Society, states (p. 25) that the insect was the common Red-legged species *(femur-rubrum)*; but specimens of this 1873 invasion, which he kindly sent me, are *spretus*, sure enough; and other specimens collected in 1874, and sent me by Professors Bessey and McAfee, of the Iowa Agricultural College, tell the same tale.

The young from the 1873 invasion destroyed most of the small grain and acquired wings, and began to leave the country in June. During the month of July, and more particularly during the first half, new clouds came from Dakota and British America and swept over very much the same counties overrun the previous year, reaching a little farther east. The clouds which came in 1874 are described as reaching 100 miles east and west and 200 miles north and south.

The Commissioner of Statistics, in his report for 1874, says that the locusts destroyed more than 50 per cent. of the crops that year in the counties of Brown, Clay, Cottonwood, Jackson, Lacquiparle, Lincoln, Lyon, Martin, Murray, Nobles, Redwood, Renville, Rock, Watonwan and Yellow Medicine; and a smaller percentage in Blue Earth, Chippewa, Faribault, Grant, Nicollet, Otter Tail, Sibley, Stevens, Swift and Wilkins.

Gov. C. K. Davis wrote to the Secretary of the War Department, about the middle of July, as follows:

> The locusts have devoured every kind of crop in the northwestern part of Minnesota. (They did the same thing last year in the same area). Many thousands are now suffering for food, and I am using every public and private source to send immediate supplies of food. This State is entitled to two years quota of arms, estimated at $8,160. I respectfully request to turn over to me, instead of arms, a quantity of rations, equivalent in value.

COLORADO—The whole of Colorado east of the mountains was more or less overrun by this insect in 1874, and great damage was reported from Conejos, El Paso, Larimer, Weld, Cache a la Poudre, from Denver to Middle Park, and in the Ralston and Clear Creek regions. In the Platte Valley they did less harm. Mr. J. D. Putnam, one of my correspondents, wrote:

> The grasshoppers (*Caloptenus spretus*) have been quite destructive in this territory this year. They put in their first appearance at Valmont, Boulder county, on July 11, though I saw them on Gold Hill (in the Mts.) on July 8. The first lot remained several days and went off, but it was soon followed by another lot, and so they seemed to keep on coming. The wheat was nearly ready for harvest when they first came, consequently there is not the destitution among the farmers that there is in Nebraska.

Mr. O. A. Whittemore, Secretary of the Colorado Industrial Association, wrote:

> Our visitation this year came from the North and West. The first invasion crossed the mountains much to the north of us and coming down along the base of the mountains, and after doing much damage, leaving for the South. A late swarm came across the mountains directly west of us, and when leaving, seemed to be going South.

As this insect breeds in most of the western, mountainous part of Colorado, this State suffers more or less from its injuries every year. The insect is, in fact, the greatest pest to Colorado agriculture. Yet it is only when fresh swarms sweep through the mountain passes and canyons in darkening clouds, or when they bear down in multitudes from the plains to the northwest as they did last year, that they are considered an unavoidable calamity. As a rule these fresh accretions come so early in the season as to pass on to the south or southwest without laying eggs; but very often they come late enough to lay their eggs—the progeny from which is much more to be dreaded than with us, because it is more healthful and vigorous and does much more damage.

DAKOTA.—This Territory was also overrun in 1873 as well as 1874. From the meagre data at my disposal, the settled portions were almost completely ravaged, and in the southeastern half scarcely a wheat-field escaped destruction. The late lamented M. L. Dunlap, in his "Rural" correspondence to the Chicago *Tribune*, gives the following picture of affairs in D. T.:

> The Grasshopper has proven a burden, and the sound of the grinding is low, and the emigrant wagon with its white cover is traveling East instead of West. A letter before me from Dakota says: "If the grasshoppers scourge us another year, Dakota will become desolate, and be remanded to her ancient solitude. This is the fourth year of bad crops, and almost every farmer has a mortgage on his goods and chattels, to tide them over the past. Many have left, not to return, and others are to come back in the Spring. At the best, the outlook is blue with despair." This will turn back an army of laborers; for all those people, when they turn back, will need work, and this they should have, if possible. These people are returning from an immense belt of country, and the vanguard is already here, with the main army to follow. A little marauding insect, born of the mountains, has driven them back, and may hold the country for a long time. The pleasant dreams of the homesteader have been brought to a close, and unpleasant images have usurped the place. Even without the grasshoppers, pioneer life is a great struggle that none can fully appreciate until they have passed its exacting ordeal.

From Montana and Wyoming, where these insects are at home, and where, from the nature of the country, settlements are very sparse and agriculture scarcely has an existence, the reports of injury are meagre.

MANITOBA.—Their injuries in 1874 were severely felt in Manitoba. The shores of Manitoba Lake were reported as at one time strewn three feet thick with their dead carcasses, where they had been driven into the lake and cast ashore; while in the South, from Pembina to Stinking River, at Palestine, Boyne Settlement, Portage la Prairie, Rat Creek, Rockwood and Winnepeg, they were reported as utterly destroying oats, barley and other crops. From Mr. Geo. M. Dawson, of McGill College, Montreal, who, as Geologist and Naturalist of the N. A. Boundary Commission, has been collecting information as to the limits of the insect in this province, I learn that the usual eastern limit is formed by the edge of the wooded country, which crosses the forty-ninth parallel about lon. 96° 30′, and runs thence to the south end of Lake Winnepeg. A line drawn from Fort Garry to the forks of the Saskatchewan river; thence to Fort Edmonton, and thence to the intersection of the Rocky Mountains and forty-ninth parallel; gives approximately the limit of the open prairie country. Over the whole area to the south of this line, the Locust is, he believes, frequently found in swarms. Mr. Dawson also informs me that they have been known to reach, in years past, a number of miles into the wooded country, as far east as the Lake of the Woods; or in other words, to about the same limit line that they reach in Missouri.

ITS FLIGHT AND RAVAGES.

[Fig. 32.]

A swarm of Locusts falling upon and devouring a wheat-field.

The voracity of these insects can hardly be imagined by those who have not witnessed them, in solid phalanx, falling upon a corn-field and converting, in a few hours, the green and promising acres into a desolate stretch of bare, spindling stalks and stubs. Covering each hill by hundreds; scrambling from row to row like a lot of young famished pigs let out to their trough; insignificant individually, but mighty collectively—they sweep clean a field quicker than would a whole herd of hungry steers. Imagine hundreds of square miles covered with such a ravenous horde, and you can get some realization of the picture presented last year in many parts of Kansas.

Their flight may be likened to an immense snow storm, extending from the ground to a height at which our visual organs perceive them only as minute, darting scintillations—leaving the imagination to picture them indefinite distances beyond. "When on the highest peaks of the snowy range, fourteen or fifteen thousand feet above the sea, I have seen them filling the air as much higher as they could be distinguished with a good field glass."* It is a vast cloud of animated specks, glittering against the sun. On the horizon they often appear as a dust tornado, riding up on the wind like an ominous hail storm, eddying and whirling about like the wild dead leaves in an Autumn storm, and finally sweeping up to and past you, with a power that is irresistible. They move mainly with the wind and when there is no wind they whirl about in the air like swarming bees. If a passing swarm suddenly meets with a change in the atmosphere, "such as the approach of a thunder-storm, or gale of wind, they come down precipitately, seeming to fold their wings, and fall by the force of gravity, thousands being killed by the fall, if it is upon stone or other hard surface."† In alighting, they circle in myriads about you, beating against everything animate or inanimate; driving into open doors and windows; heaping about your feet and around your buildings; their jaws constantly at work biting and testing all things in seeking what they can devour. In the midst of the incessant buzz and noise which such a flight produces; in face of the unavoidable destruction everywhere going on, one is bewildered and awed at the collective power of the ravaging host, which calls to mind so forcibly the plagues of Egypt.

The noise their myriad jaws make when engaged in their work of destruction, can be realized by any one who has "fought" a prairie fire, or heard the flames passing along before a brisk wind: the low crackling and rasping—the general effect of the two sounds, are very similar. Southy, in his Thalaba,‡ most graphically pictures this noise produced by the flight and approach of locusts:

> "Onward they come, a dark, continuous cloud
> Of congregated myriads numberless,
> The rushing of whose wings was as the sound
> Of a broad river headlong in its course
> Plunged from a mountain summit, or the roar
> Of a wild ocean in the Autumn storm,
> Shattering its billows on a shore of rocks!"

Nothing, however, can surpass the prophet Joel's account of the

* Wm. N. Byers, *Am. Entomologist*, I. p. 94.

† Wm. N. Byers, Hayden's Geol. Surv., 1870, p. 282.

‡ I., 169.

appearance and ravages of these insects. Omitting the figurative parts, it is accurate and graphic beyond measure:

"A day of darkness and of gloominess, a day of clouds and of thick darkness, as the morning spread upon the mountains; a great people and a strong; there hath not been ever the like, neither shall be any more after it, even to the years of many generations. A fire devoureth before them; and behind them a flame burneth; the land is as the garden of Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. The appearance of them is as the appearance of horses; and as horsemen, so shall they run. Like the noise of chariots on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array. Before their face the people shall be much pained: all faces shall gather blackness. They shall run like mighty men; they shall climb the wall like men of war; and they shall march every one on his ways, and they shall not break their ranks. * * * They shall run to and fro in the city; they shall run upon the wall, they shall climb up upon the houses; they shall enter in at the windows like a thief."

Those who suffered from and witnessed the vast army that cast a blight over so large a portion of our Western country last year; or who passed by rail, during the better part of two days, through a perfect storm of these insects, which frequently impeded or stopped the train by their crushed bodies reducing the traction—will concede that Joel's picture is not overdrawn, and that, though written over 2,500 years ago, it might have been inspired from many parts of North America in the year 1874. The illustration (Fig. 32) which I give herewith, is reduced from one published last August in the *Scientific American*, and, though not accurate in structural detail, conveys a very good idea of the appearance of a swarm invading a wheat-field.

FOOD PLANTS.

The Rocky Mountain Locust may be said to be almost omnivorous. Scarcely anything comes amiss to the ravenous hosts when famished. They will feed upon the dry bark of trees or the dry lint of seasoned fence planks; and upon dry leaves, paper, cotton and woolen fabrics. They have been seen literally covering the backs of sheep, eating the wool; and whenever one of their own kind is weak or disabled, from cause whatsoever, they go for him or her with cannibalistic ferocity, and soon finish the struggling and kicking unfortunate. They do not refuse even dead animals, but have been seen feasting on dead bats and birds. Few things, therefore, come amiss to them. Yet where food is abundant they are fastidious and much prefer acid, bitter or peppery food to that which is sweet. The following resume of my notes and observations may prove interesting: Vegetables and cereals are their main stay. Turnips, rutabagas, carrots, cabbage, kohlrabi and radishes are all devoured with avidity; beets and potatoes with less relish, though frequently nothing but a few stalk-stubs of the latter are left, and sometimes the tubers in the ground do not escape. Onions they are very partial to, seldom leaving anything but the outer rind. Of leguminous plants the pods are preferred to the leaves, which are often passed by. Cucurbitaceous plants also suffer most in the fruit. In the matter of tobacco their tastes are cultivated and they seem to relish an old quid or an old cigar more than the green leaf. Tomatoes and sweet potatoes are not touched so long as other food is to mouth.

Of cereals, corn is their favorite; if young and tender, everything is devoured to the ground; if older and drier, the stalks are mostly left; the silk is, however, the first part to go. All other cereals are to their taste, except sorghum and broom-corn, which are often left untouched. They are fond of buckwheat and flax, but seldom touch castor beans.

Next to vegetables and cereals, they relish the leaves of fruit trees; they strip apple and sweet cherry trees, leaving nothing but the fruit hanging on the bare twigs. The leaves of the peach are generally left untouched, but the flesh of the unripe fruit is eaten to the stone. Pear trees, as Mr. Gale informs me, suffered less than any other kind of orchard tree at the Experimental farm at Manhattan, Kansas. The tender bark of twig and branch and trunk of all these trees is gnawed and girdled, and these girdled trees present a sad picture as one passes through the ravaged country during the subsequent Winter. Sour cherry, apricot and plum trees are less affected by them, while ripe fruit is seldom touched.

Of berries, strawberries and blackberries are devoured where raspberries are frequently unmolested. Flowering shrubs very generally suffer, and they are particularly fond of Rose and Lilac. Of herbaceous plants, Helianthus, Amaranthus and Xanthium are eaten with especial avidity. Grape vines suffer more from the girdling of the fruit stems than from defoliation. Forest and shade trees suffer in different degrees, and some, when young, are not unfrequently killed outright.

Last year, Honey Locust, Red Cedar, Box Elder, Osage Orange, Elm and Oak, were either untouched or but little injured, while the following trees were preferred in the order of their naming: Ash, Willow, Cottonwood, Balm of Gilead, Silver-leaved and Lombardy poplars, Black Ash, Black Locust, Black Walnut, Hickory, Ailanthus, Maple, Sumach and Evergeens.

In every case they show a marked preference for plants that are unhealthy or wilted.

TIME OF APPEARANCE.

In endeavoring to deduce some general conclusions respecting the time of year that the 1874 swarms reached different parts of the country, great difficulty is experienced in sifting those accounts which refer to the progeny of the 1873 invasion, and the new comers which hatched within the insect's native range. Yet we shall find, as a rule, that the insects which hatch outside the native habitat—i. e., in Minnesota, Iowa, Missouri, and the larger part of Nebraska and Kansas—acquire wings and leave before the new swarms appear. In the more northerly of the States, as in Minnesota, the insects hatched on the ground acquire wings in June, and earlier in proportion as we go south, until in Texas they become fledged in April. The time of appearance of the new swarms is in inverse ratio ; i. e., earlier in the more northern, later in the more southern States. Thus, while on the confines of the insect's native habitat, it is almost if not quite impossible to distinguish between the old and the new comers, in respect to the time of their acquiring wings; the difference in this respect becomes greater the farther south and east we go. The 1874 swarms appeared during June in Southern Dakota, during July in Colorado, Nebraska and Minnesota; during the latter part of this month in Iowa and Western Kansas. During August, they came into Southeast Kansas and Missouri; and by the middle of October they reached Dallas, in Texas.

One noticeable feature of the invasion was the greater rapidity with which the insects spread in the earlier part of the season, while in fullest vigor, and the reduction in the average rate of progress the farther east and south they went. The length of their stay depends much on circumstances. Early in the Summer, when they first began to pour down on the more fertile country, they seldom remained more than two or three days, whereas, later in the season, they stayed much longer. In speaking of the advent and departure of these insects, I use relative language only. The first comers, when—after having devoured everything palatable—they take wing away, almost always leave a scattering rear-guard behind, and are generally followed by new swarms ; and a country once visited presents for weeks the spectacle of the insects gradually rising in the air between the hours of 9 or 10 A. M. and 3 P. M., and being carried away by the wind, while others are constantly dropping.

ITS NATIVE HOME: IT CANNOT THRIVE IN THE MISSISSIPPI VALLEY, AND CAN NEVER REACH FAR INTO MISSOURI.

A full month before a single specimen of the Rocky Mountain Locust reached Missouri in 1874, I prophesied that it would come into our western counties too late to do any very serious damage, and that it would not reach beyond a given line.* To the many anxious correspondents who, fearing that the State was to be overrun, as Kansas was being overrun, wrote for my opinion and advice, I replied: "Judging of the future by the past, the farmers of Missouri, east of the extreme western tier of counties need fear nothing from Locust invasions. They may plant their Fall grain without hesitation, and console themselves with the reflection that they are secure from the unwelcome visitants which occasionally make their way into the counties mentioned, and especially of the northwest corner of the State. The same holds true of the farmers of Illinois and of all the country east of a line drawn, at a rough estimate, along longitude 17° West from Washington."

The detailed account already given (p. 144) of the counties in Missouri invaded in 1874, will show how subsequent events bore out my prophesy, and how the insect reached just about the limit I had given it. But, it will be asked, "Upon what do you base this conclusion, and what security have we, that at some future time the country east of the line you have indicated may not be ravaged by these plagues from the mountains?" I answer that during the whole history of the species as I have attempted to trace it in the chronological account already given, the insect never has done any damage east of the line indicated, and there is no reason to suppose that it ever will do so for the future. There must of course be some limit to its flight, as no one would be foolish enough to argue that it could, in one season, fly to England or France, or even to the Atlantic ocean ; and as its flight is by law limited to one season—for the term of life allotted to it is bounded by the Spring and Autumn frosts—so its power of flight is limited. And as the historical record proves that it never has done any dam-

* *St. Louis Globe*, July 20, 1874.

age east of the line indicated, it is but logical to infer that it never will. "Because an insect can fly 550 miles, it would be ridiculous to argue that, therefore, it can fly 700 miles. We might as well claim that because a man can jump a ditch twenty feet wide, therefore he can jump another ditch which is thirty feet wide; or because a man can easily carry a young calf upon his back, therefore, if he practices daily, he will be able to carry the same animal upon his back when it has grown to be a cow."*

My late friend, B. D. Walsh, who, from a number of data which he accumulated, first laid stress on this fact that the insect would in all likelihood never reach the Mississippi river, gives his reasons in the following concluding paragraph of his report as acting State Entomologist of Illinois:

> Every man—except, perhaps, some crazy Millerite—believes firmly that, in all human probability, the sun will rise in Illinois every morning for hundreds of years to come. Yet he has no other kind of evidence to justify such a belief, than I have to justify the truth of my theory, namely, that in all human probability we shall never for hundreds of years to come, be afflicted with the Hateful Grasshopper in Illinois. Both the inorganic and organic worlds are governed by certain fixed laws; and whether it be a vast fiery globe of liquid larva, revolving slowly upon its axis in the midst of the attendant worlds that have been circling around it, each in its own peculiarly prescribed path, for indefinite ages, or whether it be some infinitesimally minute insect, winging its way from the alpine heights of the Rocky Mountains over the Desert Plains of the West; we have but to ascertain by what laws each of them is governed, in order to be able to predict, in the case of each of them, what is and what is not morally certain to happen in the future.

"But why," it will again be asked, "will not the young from the eggs laid along the eastern limit you have indicated, hatch and spread further to the eastward?" Here, again, historical record serves us, and there are, in addition, certain physical facts which help to answer the question.

There is some difference of opinion as to the precise natural habitat and breeding place of these insects, but the facts all indicate that it is by nature a denizen of high altitudes, breeding in the valleys, parks and plateaus of the Rocky Mountain region of Colorado, and especially of Montana, Wyoming and British America. Prof. Cyrus Thomas, who has had an excellent opportunity of studying it—through his connection with Hayden's geological survey of the Territories—reports it as occurring from Texas to British America and from the Mississippi (more correctly speaking the line I have indicated) westward to the Sierra Nevada range. But in all this vast extent of country, and especially in the more southern latitudes, there is every reason to believe that it breeds only on the higher mountain elevations, where the atmosphere is very dry and attenuated, and the soil

†Am. Ent. I, p. 75.

seldom, if ever, gets soaked with moisture. Prof. Thomas found it most numerous in all stages of growth along the higher valleys and canyons of Colorado, tracing it up above the perennial snows, where the insect must have hatched, as it was found in the adolescent stage. In crossing the mountains in Colorado it often gets chilled in passing the snows, and thus perishes in immense numbers, when bears delight to feast upon it.

My own belief is that the insect is at home in the higher altitudes of Utah, Idaho, Colorado, Wyoming, Montana, Northwest Dakota and British America. It breeds in all this region, but particularly on the vast hot and dry plains and plateaus of the last named Territories and on the plains west of the mountains; its range being bounded, perhaps, on the East by that of the Buffalo grass. Mr. Wm. N. Byers, of Denver, Colorado, shows that they hatch in immense quantities in the valleys of the three forks of the Missouri river and along the Yellow Stone, and how they move on from there, when fledged, in a southeast direction at about 10 miles per day. The swarms of 1867 were traced, as he states, from their hatching grounds in West Dakota and Montana, along the east flank of the Rocky Mountains, in the valleys and plains of the Black Hills, and between them and the main Rocky Mountain range.*

In all this immense stretch of country, as is well known, there are immense tracts of barren, almost desert land, while other tracts for hundreds of miles bear only a scanty vegetation, the short buffalo grass of the more fertile prairies giving way, now to a more luxurious vegetation along the water courses, now to the sage bush and a few cacti. Another physical peculiarity is found in the fact that while the Spring on these immense plains often opens as early, even away up into British America, as it does with us in the latitude of St. Louis, yet the vegetation is often dried and actually burned out before the first of July, so that not a green thing is to be found. Our Rocky Mountain Locust, therefore, hatching out in untold myriads in the hot sandy plains, five or six thousand feet above the sea level, will often perish in immense numbers if the scant vegetation of its native home dries up before it acquires wings; but if the season is propitious and the insect becomes fledged before its food supply is exhausted, the newly acquired wings prove its salvation. It may also become periodically so prodigiously multiplied in its native breeding place that, even in favorable seasons, everything green is devoured by the time it becomes winged.

* See Hayden's Geol. Survey of the Territories, 1870, pp. 282-3.

In either case, prompted by that most exigent law of hunger—spurred on for very life—it rises in immense clouds in the air to seek for fresh pastures where it may stay its ravenous appetite. Borne along by the prevailing winds that sweep over these immense treeless plains from the northwest, often at the rate of 50 or 60 miles an hour, the darkening locust clouds are soon carried into the more moist and fertile country to the southeast, where, with sharpened appetites, they fall upon the crops like a plague and a blight. Many of the more feeble or of the more recently fledged perish, no doubt, on the way; but the main army succeeds, with favorable wind, in bridging over the parched country which offers no nourishment. The hotter and drier the season, and the greater the extent of the drouth, the earlier will they be prompted to migrate, and the farther will they push on to the East and South.

The comparatively sudden change from the attenuated and dry atmosphere of five to eight thousand feet or more above the sea level, to the more humid and dense atmosphere of one thousand feet above that level, does not agree with them. The first generation hatched in this low country is unhealthy, and the few that attain maturity do not breed, but become intestate and go to the dogs. At least such is the case in our own State and in the whole of the Mississippi Valley proper. As we go West or Northwest and approach nearer and nearer the insect's native home, the power to propagate itself and become localized, becomes, of course, greater and greater, until at last we reach the country where it is found perpetually. Thus in the western parts of Kansas and Nebraska the progeny from the mountain swarms may multiply to the second or even third generation, and wing their way in more local and feeble bevies to the country east and south. Yet eventually they vanish from off the face of the earth, unless fortunate enough to be carried back by favorable winds to the high and dry country where they flourish. That they often instinctively seek to return to their native haunts is proven by the fact that they are often seen flying early in the season in a northwesterly direction.* As a rule, however, the winds which saved the first comers from starvation by bearing them away from their native home, keep them and

* Mr. Affleck, in the letter published in the Appendix, shows that they frequently take this direction in leaving Texas. Mr. S. T. Kelsey also writes me: In the Spring of 1874, I think late in May, they passed over the same country (between Hutchinson and Dodge counties in Kansas) going north, flying high as before, and none of them alighting so far as I could see or learn. They were observed by many persons besides myself, but as they did no harm there was little said about them. Mr. G. M. Dodge, of Glencoe, Dodge county, Neb., (*Prairie Farmer,* September 19, 1874,) also records their passing over that place in a northerly direction during the last of May—a date indicating that they must have been born in more Southern latitudes. See also Mr. Faulkner's letter, on page 141 of this Report.

their issue to the east and south, and thus, in the end, prove their destruction. For in the Mississippi Valley they are doomed, sooner or later.

There is nothing more certain than that the insect is not autochthonous in West Missouri, Kansas, Nebraska, Iowa, or even Minnesota, and that when forced to migrate from its native home, from the causes already mentioned, it no longer thrives in this country.

That the native home of the species is sub-Alpine, is proved by the fact of its abounding to such an extent in British America, and of its breeding in the higher mountain elevations, even up to the perennial snows. In fact, so high up does it breed that it often hatches so late in the season as to be overtaken by the cold of the succeeding Winter before acquiring growth, when of course it perishes without begetting. The truly Alpine country cannot, therefore, be its native home; and those found breeding at such a height must be the progeny of others which flew from the plains, either east or west of the mountains. Physical barriers on the high mountain summits put a limit to the insect's extension and propagation, just as they do in the Mississippi Valley.

Such are my opinions, based upon my own observations in Missouri, Kansas, Nebraska and Colorado; on those of a large number of correspondents, and especially upon the experience of men like Mr. Byers and Prof. Thomas, who have given the subject particular attention. In treating of the native home of the species, I have confined myself, as in all other cases in speaking of the insect, as much as possible, to the country east of the Rocky Mountain Range: I leave to others to trace its history beyond the mountains.

Beyond the boundary line indicated in my map (Fig. 32), they did not reach in 1874, and beyond that line I do not believe they will ever do any damage. Not that they may not extend to some extent beyond that line, in years to come, or that the young, hatching in 1875, will not push beyond it; for I have numerous records to show that they have occurred as far as the western point of Lake Superior, and that they have even reached the Mississippi in parts of Iowa: but in all such instances they appeared in scattering numbers only, and did no material damage. They were the last remnants of the mighty armies from the mountains, moving and blowing about, diseased, parasitised, intestate and wasting away.

Well is it for the people of Missouri; well is it for the people of the Mississippi Valley, generally, that this insect cannot go on multiplying indefinitely in their fertile fields! Else, did it go on multiplying and thriving as the Colorado Potato-beetle has done, this whole valley would soon become a desert waste. A wise Providence has decreed that thus far it shall go, and no further.

It will surely be a source of satisfaction to the farmers east of the line indicated to feel assured against any future invasion by, or any serious injury from, an army of insects so prodigiously numerous as actually to obscure the light of the sun, and so ruinously destructive as to devour almost every green thing that grows!

WHAT INJURY MAY BE EXPECTED IN MISSOURI IN 1875?

The subject we have just been considering, brings us very naturally to the question propounded in the above heading. It is also a question of vital importance to the farmers in our western counties, and one that will be repeatedly asked this coming Spring; and as there prevails an erroneous impression that I have given it as my opinion that no damage can possibly result from the young hatching out in 1875, I will here repeat what I actually said on the subject last Autumn.

Setting aside possible but not probable injury from a new invasion, we may consider the probable injury that will result in 1875 from the progeny of those which came in 1874. The eggs which are deposited on southerly hill-sides often hatch before cold weather sets in, if the Fall is warm and protracted, while many hatch soon after the frost is out of the ground in the Spring. Yet the great bulk of them will not hatch till into April. That most of the eggs will hatch may be taken for granted unless we have very abnormal climatic conditions, and unprecedentedly wet and cold weather following a mild and thawing spell. The young issuing from these eggs will also, in all probability, do much damage, as they did in the Spring and Summer of 1867. But the actual damage cannot be foretold, as so much depends on circumstances. In 1867, in many counties of Kansas and Missouri, where the ground had been filled with eggs the previous Fall, little harm was done in the Spring—so small a percentage of the eggs came to anything and so unmercifully were the young destroyed by natural enemies. A severe frost kills the young after they have hatched, where a moderate frost does not affect them. In Missouri, if we have no weather that proves fatal to either eggs or young, considerable damage may be expected, but not as much as in the country to the West; for, as already stated, we received the more scattering remains of the vast army, and the eggs are neither as numerous, nor will they hatch as early in our territory as farther West. Following a rather mild February the March of '67 was a very severe one, the thermometer frequently indicating 18 degrees below zero, and according to Mr. W. F. Goble, of Pleasant Ridge, Kansas, who wrote an excellent account of the insect,* this severe weather caused many of the eggs to perish; and he expresses the opinion that "judging from the voraciousness of those that did appear, I doubt not Kansas would have been made a perfect desert if all had lived."

If after the young hoppers hatch we have much cold wet weather, great numbers of them will congregate in sheltered places and perish before doing serious harm; but if, on the contrary, our Spring and early Summer prove dry and hot (which is hardly to be expected after the several dry seasons lately experienced) much damage will result from these young locusts, where no effort is made to prevent it. They will ruin most garden truck, do much injury to grain, and affect plants very much in the order previously indicated under the head of "Food-plants." They will become more and more injurious as they get older, until, in about two months from the time of hatching, or about the middle of June, they will begin to acquire wings, become restless, and in all probability leave the locality where they were born, either wending their way further South or returning in the direction whence their parents came the previous year. Some bevies may even pass to the eastward of the limit line reached in 1874, and fall upon some of the counties bordering that line; but they will lay no eggs, and will in time run their course and perish from debility, disease and parasites. In 1876 the Rocky Mountain Locust will scarcely be heard of within our borders; a few remnants from Kansas or Nebraska, or from the country to the southwest, may make their presence manifest, if the year should be exceptionally favorable to their development; but, whether delayed till 1876, or even till 1877, the last one will eventually vanish from Missouri soil, and their race will no more be known among us till—perhaps within the next six or eight years; perhaps not within the next twenty—a fresh swarm wings its way to our borders from the plains along the mountain regions. There is, therefore, no danger of their overrunning the State to the east of the limit line; nor of their doing permanent injury in the counties they now occupy.

RAVAGES OF MIGRATORY LOCUSTS IN THE ATLANTIC STATES.

We have already seen how the true Rocky Mountain Locust, which rarely reaches the Mississippi, may be distinguished from the Red-legged species, which often mixes with it and is common to a much larger extent of country, and reaches to the Atlantic. We have also

* Monthly Reports, Dept. Agr. 1867 p. 290.

seen that the ravages of migratory locusts between the Mississippi and the Rocky Mountains, and probably to the Pacific, are confined to the one, long-winged species, (*spretus*). "How then," will naturally be asked, "do you account for the ravages of migratory locusts in the Atlantic States, since swarms have been known in those States to fly over the country and commit sad havoc, and since you tell us that the Red-legged species is incapable of such migrations?" This question, which has never been properly answered, I will now proceed to elucidate.

First, as to migrating locusts doing great damage in some of the Eastern States during certain years, there can be no doubt of the fact. Harris, in his Treatise, gives an account extracted from the Travels of President Dwight, wherein they are recored as being most destructive in Vermont in 1797 and 1798, and as collecting in clouds, rising in the air and taking extensive flights—even covering persons employed in raising a church steeple, who, in such position, still saw the insects flying far above their heads. He also quotes from Williamson's History of Maine, that in 1749 and 1754 they were very numerous and voracious; that "in 1743 and 1756 they covered the whole country and threatened to devour everything green." Among the communications which I received last Fall was the following, descriptive of locust ravages in New Hampshire:

DEAR SIR: I see a note in the New York *Tribune* requesting those from the Locust regions to send you specimens of the variety. I send you a vial of them to-day by mail. They have been quite plenty in the Merrimack Valley on some farms. They have eaten all of our garden vegetables; in others they left us a small share. The small ones are the most plenty and the ones that have done the most mischief. I should like to know if they are of the same variety that infested the West.

Yours truly,

LEWIS COLBY.

BOSCAWEN, MERRIMACK CO., N. H., September 17, 1874.

The following account by Dr. U. T. True of the appearance of these insects in Cumberland county, Maine, in 1821, is so circumstantial that I give it in full, as quoted by Mr. S. H. Scudder:*

During the haying season the weather was dry and hot, and these hungry locusts stripped the leaves from the clover and herds-grass, leaving nothing but the naked stems. In consequence, the hay-crop was seriously diminished in value. So ravenous had they become that they would attack clover, eating it into shreds. Rake and pitch-fork handles, made of white ash and worn to a glossy smoothness by use, would be found nibbled over by them if left within their reach.

As soon as the hay was cut and they had eaten every living thing, they removed to the adjacent crops of grain, completely stripping the leaves; climbing the naked stalks they would eat off the stems of wheat and rye just below the head, and leave them to drop to the ground. I well remember assisting in sweeping a large cord over the heads of wheat after dark, causing the insects to drop to the ground, where most of them would remain during the night. During harvest time it was my painful duty,

* Hayden's Report on the Geological Survey of Nebraska; and "The Distribution of Insects in New Hampshire," p. 375.

with a younger brother, to pick up the fallen wheat heads for threshing; they amounted to several bushels.

Their next attack was upon the Indian corn and potatoes. They stripped the leaves and ate out the silk from the corn, so that it was rare to harvest a full ear. Among forty or fifty bushels of corn spread out in the corn-room, not an ear could be found not mottled with detached kernels.

While these insects were more than usually abundant in the town generally, it was in the field I have described that they appeared in the greatest intensity. After they had stripped everything from the field, they began to emigrate in countless numbers. They crossed the highway and attacked the vegetable garden. I remember the curious appearance of a large, flourishing bed of red onions, whose tops they first literally ate up, and not content with that, devoured the interior of the bulbs, leaving the dry external covering in place. The provident care of my mother, who covered the bed with chaff from the stable floor, did not save them, while she was complimented the next year for so successfully sowing the garden down to grass. The leaves were stripped from the apple trees. They entered the house in swarms, reminding one of the locusts of Egypt, and, as we walked, they would rise in countless numbers and fly away in clouds.

As the nights grew cooler they collected on the spruce and hemlock stumps and log fences, completely covering them, eating the moss and decomposed surface of the wood, and leaving the surface clean and new. They would perch on the west side of a stump, where they could feel the warmth of the sun, and work around to the east side in the morning as the sun reappeared. The foot-paths in the fields were literally covered with their excrements.

During the latter part of August and the first of September, when the air was still dry, and for several days in succession a high wind prevailed from the northwest, the locusts frequently rose in the air to an immense hight. By looking up at the sky in the middle of a clear day, as nearly as possible in the direction of the sun, one may descry a locust at a great hight. These insects could thus be seen in swarms, appearing like so many thistle-blows, as they expanded their wings and were borne along toward the sea before the wind; myriads of them were drowned in Casco bay, and I remember hearing that they frequently dropped on the decks of coasting vessels. Cart loads of dead bodies remained in the fields, forming in spots a tolerable coating of manure.

Mr. J. S. Smith says that he has seen "hackmatack trees almost covered with them, and entirely stripped of their leaves."*

All these accounts agree in referring the injury to the common Red-legged Locust; but as I am fully persuaded that this species, as found in Illinois and Missouri, is incapable of any extended flight,† I could not help feeling that some other species had been confounded with it, and had played the part of migratory locust in the White Mountain regions of Maine and New Hampshire. It was with satisfaction therefore that, upon examining the locusts sent me by Mr Colby, I found them to belong to a new and different species, smaller than either the Rocky Mountain or the Red-legged species, but in structure and relative length of wing much more nearly resembling the former than the latter; in other words, its relative length of wing enables it to fly with almost the same facility as its Rocky Mountain congener. This species may be called the Atlantic Migratory Locust, and is described below, in comparison with its close allies:

Caloptenus Atlanis N. sp.—Length to tip of abdomen 0.70—0.85 inch; to tip of closed wings 0.92—1.05 inches. At once distinguished from *femur-rubrum* by the

* Rep. Connecticut State Bd. of Agr. 1872, p. 363.

† I do not mean by this that it is incapable of rising in the air; but I am quite sure that as found in St. Louis county it is incapable of any such flights as *spretus* takes. In the higher parts of the country, whether east or west, the power of flight may be greater.

notched character of the anal abdominal joint in the male and by the shorter, less tapering cerci; also by the greater relative length of wings which extend, on an average, nearly one-third their length beyond the tip of the abdomen in the dried specimens; also by the larger and more distinct spots on the wings—in all which characters it much more closely resembles *spretus* than *femur-rubrum*. From *spretus*, again, it is at once distinguished by the smaller size, the more distinct separation of the dark mark running from the eyes on the prothorax and of the pale line from base of wings to hind thigh; also by the anal joint in the ♂, tapering more suddenly and by the two lobes forming the notch being less marked. From both species it is distinguished not only by its smaller size but by the deeper, more livid color of the dark parts, and the paler yellow of the light parts—the colors thus more strongly contrasting.

6 ♂'s, 7 ♀'s from New Hampshire. Just as the typical *femur-rubrum* is at once distinguished from the typical *spretus* by the characters indicated; so *Atlanis*, though structurally nearer to *spretus*, is distinguished from it at a glance by its much smaller size and darker, more marbled coloring. The contrast is all the greater in the living specimens, and I have seen no specimens of *spretus* that at all approach it in these respects.

Whether this is the *femur-rubrum* as defined by DeGeer or by Harris, it is almost impossible to decide, though Harris's figure of *femur-rubrum* better represents it than the true *femur-rubrum*, as subsequently defined by Thomas, and as found in Illinois and Missouri.

It has always been a question among orthopterists, as to whether *spretus* should really be considered specifically distinct from *femur-rubrum*, and Mr. Uhler has himself expressed to me his doubts as to the two being distinct. This indecision, which I myself very freely shared, may be attributed principally to the fact that the species just described (*Atlanis*) has very generally been mistaken for *femur-rubrum*, and that the accounts of this latter rising into the air in swarms have in reality had reference to the former species. The only reference to this longer-winged species, in the East, that I am acquainted with, is that by Dr. A. S. Packard, jr., whose reference to the occurrence of *spretus* in Maine and Massachusetts, as exhibited by specimens in the museum of the Peabody Academy of Science,* doubtless applies to *Atlanis*.

Whether these three insects, as here defined, are really distinct species, or only races of one and the same, is a question that each individual entomologist will decide for himself, according to his idea of what constitutes a species. As ordinary distinctions go, however, there can be no doubt as to their specific distinctness, notwithstanding my own conviction that they merge into each other through exceptional intermediate individuals. That they will cross with each other and produce fertile progeny, I have little doubt, and that *femur-rubrum* mixes more or less with the other two, is probable; yet *spretus* and *Atlanis* can never thus cross, for they are effectually sepa-

* *Am. Naturalist*, VIII., p. 502. Since the above was written, Dr. Packard has submitted a rather poor and discolored specimen to me, and it is, as I inferred, what I here call *Atlanis*.

rated by the Mississippi Valley—a fact proved alike by *spretus*' dying out on the limit line I have mapped, and by its perishing when artificially transported in the egg and hatched in the Atlantic States.*

It is in this, as it is in almost every other instance where large material from widely different parts of the country is examined; the lines which are easily drawn between species characterized from single individuals, break down, and continually remind us of the arbitrary nature of specific definitions, and of the fact that most of the species, as defined among lower animals and plants, have no real existence in nature. There are races of *femur-rubrum* which approach even the larger *differentialis* as much as they approach *spretus*. In short, without speculating on the common origin, in the past, of all these species—and, indeed, of all species composing present genera—we behold, in a broad sense, a short-winged species (*femur-rubrum*) common to the whole country between the Rocky Mountains and the Atlantic, giving way, in the higher altitudes alike of the Rocky Mountain and the White Mountain, and probably of the Alleghany regions, to a longer-winged one; and the reason why the western long-winged species is more disastrous than that of the East, is doubtless due to its larger size and to the larger extent of table land in which it breeds, as well as to the fact that the western climate is more subject to excessive drouths, which cut off the supply of nourishment at a time when the insects are acquiring wings, and thus oblige them to migrate—such conditions occurring much more rarely in the home of the eastern species. The future orthopterist, as he studies material from all parts of the country, will very likely write: *Caloptenus femur-rubrum*, DeGeer., var. *spretus* Thomas, var. *Atlanis* Riley; but the broad fact will remain that these three forms—call them races, varieties, species, or what we will—are separable, and that they each have their own peculiar habits and destiny.

INJURY FROM OTHER NON-MIGRATORY LOCUSTS.

Almost every year, in some part or other of the country, we hear reports of injury by locusts. In 1868, for instance, while the Rocky Mountain species was attracting attention, as I have already stated, (p. 137), in many parts of the West, other non-migratory species were extremely injurious in the Mississippi Valley, and in the Eastern States. In Ohio they appeared in countless myriads during that year, and at the meeting of the Cincinnati Wine Growers' Society it was stated that they invaded the vineyards, destroying entire rows, defoli-

* See an observation by Mr. S. S. Rathvon, of Lancaster, Pa., who concludes, from experiment, that the climate there is "unwholesome" to the species. (*Am. Entomologist*, II., p. 88.)

ating the vines and sucking out the juices of the berries. In the same year I saw them in countless millions in many parts of Illinois and Missouri. They actually stripped many corn-fields in these States, and had not the crops been unusually abundant, would have caused some suffering. They were very destructive to flower and vegetable gardens.

In 1869, they were, if anything, worse than in 1868. I remember that in the vicinity of St. Louis, in addition to their ordinary injuries, they stripped the tops of Norway Spruce, Balsam Fir and European Larch; took the blossoms off Lima beans; severed grape stems, and ate numerous holes into apples and peaches, thereby causing them to rot. They were indeed abundant all over Illinois, Missouri, Iowa and even Kentucky; but attracted no attention East.

In 1871 they were again very bad, especially East, as the following items will show:

The grasshoppers (locusts) have been more numerous and destructive this year in Maine than perhaps ever before. This was partly owing to the dry weather, and with the advent of the rainy season we hope their career will be somewhat checked. In this county they are thick, but in some of the central portions of the State they literally swarm, devouring nearly every green thing before them. They did much injury to the grass-fields, and now that is cut, they have betaken themselves to the cultivated crops. In some cases whole fields of corn and beans have been completely stripped. Even the potatoes have not been spared.—[*Country Gentleman*, Aug. 10, 1871, speaking of Insects in Maine.

Grasshoppers are reported to have very seriously injured the corn, grass and grain crops (and in some cases orchards and nurseries) of the counties of Androscoggin, Franklin, Knox, Kennebec, Lincoln, Oxford, Piscataquis, Penobscot, Waldo and Somerset, in Maine. So serious has been the damage that the subject was made a topic at the recent State Agricultural Convention in that State. In Androscoggin county, they injured pastures greatly and affected the condition and price of stock. Some grain-fields were protected by drawing a rope across the heads at sunset, thus brushing off the insects and preventing feeding. In Franklin county a field of twelve acres of sweet corn was only saved by keeping a man in it continually to drive out the grasshoppers. One man in York county stopped their passage to his fields by building a brush fence around them.—[*American Agriculturist*, 1871.

These pests (the locusts) have been numerous and destructive during the past month in some portions of the Eastern States. In Sagadahoc county, Maine, the crops and pastures were injured by them very much; also in Hancock county. In Franklin many fields of grain were cut to save the crops from them and for feeding. In Oxford oats were "eaten entirely down, as clean as though fed upon by sheep." In some portions of Plymouth county, Massachusetts, they are reported to have eaten everything green. In Caledonia county, Vermont, they have been very destructive. All through Windsor they have been "a terrible scourge." In Orleans they are reported abundant, and in Windham they have done "much injury to some of the crops," In Wayne county, Pennsylvania, also, they are reported to have done much damage.—[Monthly Report Dep. of Agr. for August and September, 1871.

In 1872 they were again injurious East:

The grasshoppers are making great havoc on the grass, grain and corn. For a space of about one and a half miles square they are destroying almost everything. Clover is trimmed up all but the head; oats-fields look like fields of rushes coming up to the hight of 16 to 18 inches without leaf or head. The leaves of wheat and their kernels are eaten out. These hoppers move back and forth two or three times a day, and whole sections are almost alive with them.—[*Mirror and Farmer*, (New Hampshire) August 10, 1872.

Even in 1874 much injury by them was reported in the Mississippi Valley and eastward, and a few extracts will suffice to indicate how numerous they often were:

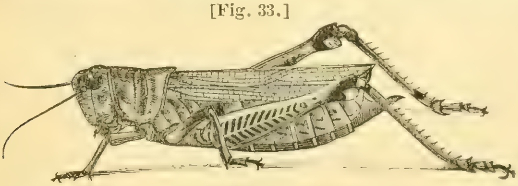
The grasshoppers destroyed four acres of my wheat last Fall; ate and destroyed my timothy twice; sowed the ground again this Spring, but as there are still plenty of hoppers there is not much hope for a stand.—[Letter extract from G. Pauls, Eureka, Mo., Nov. 10, 1874.

Some of our good friends in Suffolk county, Virginia, were unduly excited this Summer over the idea that the Western destructive grasshopper, *Caloptenus spretus* of Uhler, had found its way to the "sacred soil of Virginia." There was no denying the fact that myriads of grasshoppers were devouring nearly "every green thing," even settling on the trunks and limbs of trees, and gnawing the bark in a most unkind manner; and as it appeared to be something altogether foreign to the locality, of course, it must be the western pest. Specimens were forwarded to us, however, and a glance was sufficient to show us there was no need for alarm, as it was quite a common species in this part of the United States, and though rather too plentiful in this particular locality, would not spread or become the terror that its western distant relative has proved. The insect is known as the *Acridium Americanum*, and is of large size, often measuring over two and a half inches in length.—[C. R. Dodge, in *Rural Carolinian*. November, 1874.

In short, during hot and dry years, which are favorable to the multiplication of crickets and locusts, more or less injury is done, in all parts of the country by species indigenous to the different localities, but which in ordinary seasons do not attract any special attention. In every case, however, except in the mountain regions where the Eastern and the Western long-winged species are at home, or the country to which they migrate; the injury is caused by non-migrating species.

The principal depredator in such cases, in the Mississippi Valley, is the wide-spread Red-legged Locust, already described and illustrated, (p. 125) and so often confounded with the true migrating Rocky Mountain species. The next most injurious is the Differential Locust (*Caloptenus differentialis*, Walk., Fig. 33), a species at once distinguished, in the more typical specimens, from the preceding, not only by its larger size, but by its brighter yellow and green colors. The head and thorax are olive brown, and the front wings very much of the same color, and without other marks have a brownish shade at base, the hind wings being tinged with green; the hind thighs are bright yellow, especially below, with the four black marks as in *spretus*, and the hind shanks are yellow with black spines, and a black ring near the base. Next in injuriousness comes the Two-striped Locust (*Caloptenus bivittatus*, Say, Fig. 34,) also a larger species, of a dull, olive-

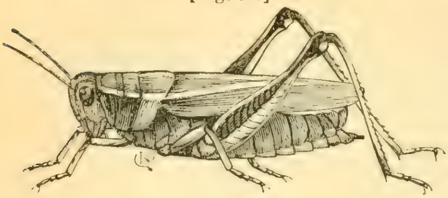
[Fig. 33.]



DIFFERENTIAL LOCUST.

green color, the hind thighs conspicuously yellow beneath, and with two yellow lines extending from above the eyes along each side of the thorax superiorly, and thence, more distinctly on the front wings, narrowing and approaching toward their tips, when closed. All these species belong to the same genus as our Rocky Mountain Locust, and, except in being unable to sustain flight agree with it in habit.

[Fig. 34.]



TWO-STRIPED LOCUST.

There are several locusts belonging to other genera which are common over large areas from the Atlantic to the Mississippi; and some of them, belonging to the genera *Acridium* and *Œdipoda* have relatively longer wings than the common Red-legged Locust, and consequently greater power of flight. Yet they are seldom as injurious as the short-winged Calopteni just enumerated, and the swarming of *Acridium Americanum* (our largest species), as described in the paragraph from the *Rural Carolinian* is quite exceptional.

ENEMIES AND PARASITES.

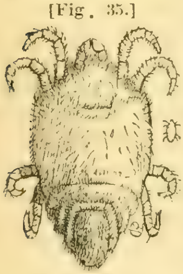
It is fortunate for man that, as in the case of most noxious insects, this locust is not without its numerous enemies. Chickens, turkeys and hogs devour immense quantities, and are happy during years of locust invasion, or whenever these insects abound. Prairie chickens and quails devour them with avidity, and even hunt for their eggs; swallows and blackbirds pursue them unrelentingly; the little snow birds devour great quantities of eggs when these are brought to the surface by the freezing and thawing of the ground; and the same may be said of almost all birds inhabiting the Western country in Winter; for in the crops of warblers, plovers, snipe and other birds killed by the telegraph wires in the vicinity of Lawrence, Kansas, my friend, G. F. Gaumer, found these eggs last Winter. The Shrike, or Butcher-bird, impales them on to thorns and other pointed substances; and a number of other birds, as well as reptiles, e. g. toads, frogs and snakes, feast upon them. But by far the most effective helps in weakening the vast armies of locusts, are the parasitic insects, albeit their work is perhaps less noticeable and less appreciated. Passing over the few, like certain species of Digger Wasps, belonging to the genus *Scolia*, which occasionally bury a few specimens as provision for their young; the ferocious Asilus-flies, which occasionally pounce upon a specimen and suck out its juices, and the omnivorous ant, which is reported as feeding on the eggs and on the weak, sickly and disabled hoppers—it will be well to treat more fully of those parasitic species which render effective service to man in destroying this locust. These consist principally of two mites (class *Arachnida*,) which are external feeders, and two Dipterous flies belonging to the family *Muscidæ*, which are internal feeders.*

THE SILKY MITE (*Trombidium sericeum* Say, Fig. 35).—Last May, Prof. C. E. Bessey sent me a pale red mite with an account of its attacking the eggs of the Rocky Mountain Locust in northwestern Iowa, and numerous accounts were published of the efficient work of this little animal in destroying said eggs, wherever these had been deposited in Iowa and Minnesota. The following may be quoted as a sample:

> A discovery has been made of great interest. A small red bug, or spider, about the size of a small kernel of wheat, is found in great numbers, creeping into the holes to the grasshopper eggs and eating the contents of the eggs voraciously. Great numbers were found in the act of eating the eggs, with empty egg-shells in the same nest. The extent of the little friends is not limited, but they have been seen in many localities in different directions in this place. Mr. J. D. Johnston, Autrim, proved conclusively that these red bugs are making sure work among the eggs.—[*Madelia* (Minn.) *Times*.

This mite belongs to the genus *Trombidium*, only two N. A. species of which have been described, viz., the *scabrum* Say, and the *sericeum* Say. The descriptions in both instances are very brief, and it is difficult to say whether the species in question, and which is herewith figured (Fig. 35) belongs to either. It answers to *sericeum* however, so far as the description goes, and I prefer to so refer it rather than describe it as new. The specimens which I have examined have not been full grown, and the pale red color which they possessed would doubtless have intensified with age. Every European is familiar with the Scarlet Mite (*T. holosericeum*, *L*), which is common in the soil of gardens in Spring and preys upon young larvæ of various descriptions. In color, silkiness and habit it greatly resembles our species and may indeed be identical. All the species of this genus are highly colored and the *Trombidium tinctorium* found in Guinea and Surinam is employed as a dye.

[Fig. 35.]

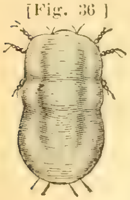


THE SILKY MITE, natural size shown at side.

* The only other internal parasite affecting locusts in this country is a small, undescribed Chalcid-fly which Mr. Scudder refers to as having bred from the eggs of *Œdipoda Carolina* (Proc. Bost. Soc. Nat. Hist., XII, p. 99). He has kindly furnished me with female specimens. They are about 0.20 inch long, pitchy black, the head and thorax very deeply pitted and roughened, and the abdomen which is flattened and quite tapering also deeply marked with irregular, longitudinal depressions. The antennae have the scape as long as the flagellum, which is curved and enlarges to tip, which is suddenly docked. The scape, basal joint of flagellum and legs are honey-yellow; the wings hyaline.

THE LOCUST MITE (*Astoma gryllaria* LeBaron, Fig. 36).—This, though a smaller mite, is even a more efficient enemy than the preceding. Almost every one who has paid any attention to the locusts must have noticed that they are often more or less covered, especially around the base of the wings, with small red mites, seldom larger than the head of a pin. These mites have but six legs which, though easily visible when the animal first attaches itself, become more or less obsolete and invisible as it swells and enlarges, though a careful examination will generally reveal them at the anterior end of the body. The mite, therefore, more often presents to the ordinary observer a bright red, swollen, ovoid body, so immovable and firmly attached by its minute jaws, that those who are not aware of its nature might easily be led into believing it a natural growth or excrescence. In fact, it attacks the Locust precisely as the different wood-ticks attack man and the lower mammals.

[Fig. 36.]



THE LOCUST MITE, greatly enlarged.

This mite belongs to the genus *Astoma*, briefly characterized by Latreille for a very similar mite (*Astoma parasiticum*) which affects the common House-fly and several other insects. The specific name *locustarum* was first proposed for it by B. D. Walsh,* but Dr. LeBaron afterwards gave it the name of *Atoma gryllaria*,† in connection with the following more detailed description:

They are of an oblong, oval form, moderately convex and having an uneven surface, produced by four shallow depressions on the upper side, the two larger near the middle, and the others behind them. The body has also two slight constrictions, giving it the appearance of being divided into three segments; but the impressions are superficial and only visible at the sides. The whole surface is finely striate, under the microscope, the striæ running in a waving transverse direction. The mouth-organs appear to be reduced to their minimum of development. The only part visible, externally, is a minute papilla, on each side of which are two bristles, the inner of which is stouter, tapering to an acute point, and curved inwards, or towards its fellow of the opposite side. They differ from the majority of Acarides in having but six legs, and these, being of but little use in so stationary a creature, are short and slender, projecting but little beyond the outline of the body. They are 6-jointed [in reality they are 5-jointed, the middle joint much the shortest, and the terminal joint longest.—C. V. R.], garnished with short stiff bristles, and terminate in two slender, curved hooks. The anterior and middle legs are closely approximate and situated near the anterior extremity of the body; the posterior are set a little nearer to each other, and a little in advance of the middle of the body, being inserted at the posterior part of the anterior division or lobe. Four hairs project from the posterior extremity of the body.

* *Practical Entomologist*, I, p. 126.

† LeBaron's 2nd Ills. Ent. Rep., 1872, p. 156. The author employs the term *Atoma*, which, though first so employed by Latreille, is corrected to *Astoma* in his "Genera Crustaceorum et Insectorum," I, p. 162, (1806).

[Fig. 37.]

Astoma parasite of the House-fly.

The dorsal figure on the opposite page (Fig. 36) exhibits the general appearance of the mite under a high magnifying power, and figure 37 which represents a ventral view of the mite found on our house-flies, and which is doubtless the *A. parasiticum* of Latreille, will better show the structure of the head and legs. During some seasons scarcely a fly can be caught that is not infested with a number of these blood-red mites, clinging tenaceously around the base of the wings.

As remarked in my last Report (p. 56) the genus *Astoma* and probably most other six-legged genera, are only larval or immature forms of some other mites; and this very Locust mite may be the larva of the Silky mite previously described, for ought we know to the contrary—there is so much to learn yet of the transformations of the Mites. Indeed, Hermann, and some other arachnologists have actually referred *Astoma* to *Trombidium.* In speaking of the Irritating Harvest Mite (*Leptus irritans* Riley, 6th Rep. p. 122) the so-called Jigger of the Mississippi Valley, and which is, in all probability, an immature form; I have stated my belief that its normal food must, apparently, consist of the juices of plants and that "the love of blood proves ruinous to those individuals who get a chance to indulge it; for unlike the true chigoe, the female of which deposits eggs in the wound she makes, these harvest mites have no object of the kind, and, when not killed at the hands of those they torment, they soon die—victims to their sanguinary appetite."* The same argument may, I think, be applied to the Locust Mite.

The Rocky Mountain Locust infested with this mite was sent to me in 1868 by Uriah Bruner, of Omaha, Nebr., and in 1869 by Clark Irvine and C. Twine, of Oregon, T. K. Faulkner, of Whitesville, and Jno. D. Dopf, of Rock Port, Mo.,—the latter gentleman stating that it was fast causing a diminution in the number of its victims. I have also received it from Minnesota and Kansas, and found it on several of our native locusts; while the following passage from an editorial account of the ravages of locusts in Kansas in 1869, which appeared in the *Prairie Farmer*, (Aug. 21, 1869,) is a sample of many newspaper accounts, and will show how efficient even a mite may be in killing.

The course of the locusts was brought to a sudden halt by the operation of some parasite, appearing in the shape of small red mites, which attach themselves to the body, under the wings, where they suck the carcass to a dry shell; the dead bodies of

* *Am. Naturalist*, Vol. VII, p. 19.

the grasshoppers almost covering some plants, where they have taken hold of a leaf or stalk, and clasped it, with a dead embrace; many others fall to the ground to die, too weak to rise again. In a half day's examination, where they were very thick, we failed to find more than two grasshoppers not so attacked, and this was not local, for a distance of thirty miles across the country they were found similarly affected.

THE ANONYMOUS TACHINA-FLY.—Our Locust, like so many other insects, is also subject to the attacks of certain two-winged flies much resembling the common House-fly, but larger. One is the very same Tachina-fly (*Tachina anonyma*) which I have bred from a number of other insects.* I first reared this fly from specimens of the Rocky Mountain Locust sent me by Jos. C. Shattuck, Vice Prest. of the Union Colony, Greeley, Col., who wrote, July 14, 1873, as follows of its work:

* * Also, I will say that the grasshoppers which a month since seriously threatened to devour every green thing, have met with a mortal foe and been slain by millions. (Don't think "millions" too large a word.) Very few have "taken to themselves wings and flown away," as heretofore, but lie dead in the fields they lately ravaged. A small fly pierces them and deposits an egg *while on the wing*, (or on the jump) and like Herod of old "they are eaten of worms and give up the ghost."

The following items undoubtedly refer to the same insect:

A Grasshopper-Exterminating Fly.—It seems that the grasshoppers that are so destructive to vegetation in many places in the central portion of the continent, are likely to find an enemy which threatens their rapid destruction. The Deer Lodge *Independent* says that a fly has made its appearance, closely resembling the common house-fly, but much larger, and of a gray, mottled color, which deposits its eggs under the wings of the Grasshopper. The egg is enclosed in a glutinous substance, which secures it in its position until the worm is matured [embryon developed.] It then penetrates the body of the Grasshopper, which speedily dies. The worm then burrows in the ground, and at the end of seventeen days comes forth a fly, ready to again commence the work of destruction. Mr. Wm. Walker, of Dempsey Creek, informs the *Independent* that twice during the past Summer the grasshoppers threatened to destroy his crops, but the flies killed them so rapidly that they did him but little damage. As the grasshoppers were killed before depositing their eggs, it is generally believed that this plague is ended in the Deer Lodge Valley.—[Published in several Montana papers in Summer of 1874.

A great many of the locusts seemed to be punctured on the back, and on pulling their heads off after death (many were found dead) from 1 to 3 ordinary looking maggots would be found. Many farmers fear it might be an introduction of a new plague. May not this gentleman with his little gimlet in time prove the destroyer of the hateful Locust?—[R. P. C. Wilson, Platte City, Mo., in private letter.

I saw a hopper kicking about as if he could hardly move; I pulled him to pieces and found that he contained a footless grub, half an inch in length. In a short time more were procured, placed in a covered tumbler, where, in a little more than two weeks, the grubs changed to Tachina flies, very much resembling the common house-flies. * * When we remember what an enormous number of eggs (fly-blows) a fly will lay and that each, in about a month, will be a perfect fly, it is seen that it would take but a few generations to clean out an army of grasshoppers—[Oscar J. Strong, Rolfe, Pocahontas county, Iowa, in *Western Farmer*, Feb., 1869.

Mr. Byers, in speaking of the locusts hatching in Colorado in 1865, (*loc. cit.*) says: "That upon attaining about half their full size, they were attacked by a fly, which, stinging them in the back between the root of the wings, deposited one or more eggs, which produced a

* See Repts. 4, p. 129 and 5, p. 133.

large white maggot. The worm subsisted upon the grasshopper, finally causing its death, when it cut its way out and entered the earth. In this way probably half were destroyed, often covering the ground, and filling the furrows in plowed fields with their carcasses. The remainder took to flight, moving southeast, when their wings were sufficiently developed, and we lost trace of them on the great Plains."

Mr. J. W. Crow, of Bigelow, Mo., in his correspondence with me, describes these maggots as infesting the "hoppers" in Holt county last Fall; and in 1869 I received the parasite from John P. Dopf, of Rock Port, Atchison county, and have bred it from the Differential Locust, figured further on, and from the Carolina Locust (*Œdipoda carolina*, L.) in St. Louis county.

Finally, Mr. S. E. Wilber, of Greely, Col., has published an account of what is evidently the same fly.* In this account, after showing how persistently the fly pursues the Locust—leaving it no rest, and so effectually weakening whole swarms as to render them harmless—he expresses the opinion that the constant importunities and annoyances of this fly are the cause of locust migrations. While, however, they may constitute a factor in the result, such a conclusion is too sweeping.

The Red-tailed Tachina-fly (Fig. 38) which is so useful in destroying the Army-worm, will serve to illustrate the species, and, indeed, differs scarcely at all except in having the tip of the abdomen red.

[Fig. 38.]

RED-TAILED TACHINA-FLY.

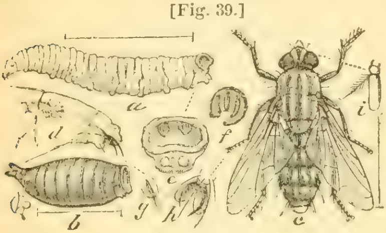
These Tachina-flies firmly fasten their eggs—which are oval, white and opaque and quite tough—to those parts of the body not easily reached by the jaws and legs of their victim, and thus prevent the egg from being detached. The slow-flying locusts are attacked while flying, and it is quite amusing to watch the frantic efforts which one of them, haunted by a Tachina-fly, will make to evade its enemy. The fly buzzes around, waiting her opportunity, and when the locust jumps or flies, darts at it and attempts to attach her egg under the wing or on the neck. The attempt frequently fails, but she perseveres until she usually accomplishes her object. With those locusts which fly readily, she has even greater difficulty; but though the locust tacks suddenly in all directions in its efforts to avoid her, she circles close around it and generally succeeds in accomplishing her purpose, either while the locust is yet on the wing, or, more often, just as it alights from a flight or a

* Popular Science Monthly, IV, p. 745.

hop. The young maggots hatching from these eggs eat into the body of the locust, and after rioting on the fatty parts of the body—leaving the more vital parts untouched—they issue and burrow in the ground, where they contract to brown egg-like pupæ, from which the fly issues either in the same season or not till the following Spring. A locust infested with this parasite is more languid than it otherwise would be; yet it seldom dies till the maggots have left. Often in pulling off the wings of such as were hopping about, the bodies have presented the appearance of a mere shell, filled with maggots; and so efficient is this parasite that the ground in parts of the western States is often covered with the Rocky Mountain Locust dead and dying from this cause.

THE COMMON FLESH-FLY (*Sarcophaga carnaria*, Linn.)—This fly, which is at once distinguished from the Tachina-fly by the style of the antenna being hairy (Fig. 39, *i*.) instead of smooth, is also a great enemy of the Rocky Mountain Locust, though I think it must be looked upon more as a scavenger than an active parasite, and that it is attracted more especially to those specimens which are feeble or already dead. I have received it among the Tachina parasites sent by Mr. Shattuck from Colorado, and from Professor C. E. Bessey, of Ames, Iowa, who bred it from the Differential Locust, and published the following description of its work:

[Fig. 39.]



SARCOPHAGA SARRACENIÆ.—*a*, larva, *b*, pupa, *c*, fly, the hair lines showing average natural lengths; *d*, enlarged head and first joint of larva, showing curved hooks, lower lip (*g*), and prothoracic spiracles; *e*, end of body of same, showing stigmata (*f*) and pro-legs and vent; *h*, tarsal claws of fly with protecting pads; *i*, antenna of same—enlarged.

A COMMENDABLE FLY.—During the Summer I noticed that many of the large yellow grasshoppers (*Caloptenus differentialis*) were infested by the maggot of a species of fly very nearly resembling, if not identical with the common Flesh-fly (*Sarcophaga carinaria*). Many of the grasshoppers were almost completely eaten out when found, retaining just sufficient strength to hop feebly over the ground. I estimate that this particular species of grasshopper was diminished in numbers at least one-tenth, possibly one-eight, by these new friends. It is to be hoped that these new parasites will increase rapidly. Professor C. V. Riley informs me that the Migratory Locust (*Caloptenus spretus*) is also infested by a similar one; thus far, however, I have failed to detect any in the specimens collected in this vicinity.

I have also bred it from a number of our native Locusts whose carcasses—forsaken by the sarcophagous larvæ—may quite frequently be seen fastened to the upright stems of different plants, in the Fall of the year. I have also bred it from the common Carolina Mantis*,

* On the 18th of October, 1868, at South Pass, Ills., I found fastened to a tree, a large female Mantis, still alive, but with the abdomen hanging down, partially decomposed, and filled with Sarcophaga larvæ. These remained in the larva state in the ground till the next July, but gave forth the flies at the end of that month. The flies marked in my cabinet *Sarcophaga carnaria*, var. *mantivora*, differ in no respect from the common *carnaria*, except in size, seven not averaging more than 0.20 inch in length.

which it attacked while living; and have known it to infest the common Walking-stick (*Spectrum femoratum*). Indeed, the species is a most widely-spread and general scavenger, occurring in most civilized countries, and feeding as a rule on dead and decaying animal matter, and only exceptionally on living insects. By way of illustrating its transformations, I introduce a figure of the Sarracenia Flesh-fly (*Sarcophaga sarraceniæ* Riley) which feeds on the dead insects caught in those curious traps, the trumpet-leaves (*Sarracenia*), and which so closely resembles the common Flesh-fly in question, that it is probably only a variety.* These flies deposit living larvæ, which are distinguished from those of the Tachina-flies by being more concave and truncated at the posterior end. (See Fig. 39, *a*.) The Tachina larva is rounded posteriorly, with a small spiracular cavity, easily closed, and having a smooth rim: it contracts to a pupa which is quite uniformly rounded at each end. The Sarcophaga larva is more truncate behind, with fleshy warts on the rim of the spiracular cavity, and with a more tapering head: it contracts to a pupa, which is also truncate behind, and more tapering in front, where the prothoracic spiracles show as they never do in Tachina.

REMEDIES: HOW BEST TO PREVENT LOCUST INJURIES.

In considering this subject, it will be advisable to classify the agencies to be employed by the husbandman in protecting himself from Locust injuries. We shall then find that they may be classed under four heads: 1st, natural agencies; 2d, artificial means of destroying the eggs; 3d, such means of destroying the unfledged young; 4th, remedies against the mature and winged insects.

1st—The natural agencies, which I have just enumerated, should be encouraged as far as it is possible to encourage them; and it is very gratifying to know that the last Kansas Legislature had a sufficient appreciation of this matter to pass a law prohibiting the destruction of prairie chickens and quails.

2d—In the destruction of the eggs, man can accomplish most in his warfare with the insect. This fact has long been recognized in all European and Asiatic countries that suffer from locust depredations; and in France, Italy and several other countries, a reward of so much

*The flies bred from *Caloptenus* have the tip of the abdomen reddish, as in *Sarcophaga sarraceniæ*, and indeed are undistinguishable from the smaller specimens of this last. The larva differs, however, in having the surface more coarsely granulated; it being regularly and uniformly covered with minute papillæ; in the less conspicuous prothoracic spiracle; in the smaller but deeper anal cavity; and in the rim of this cavity having the twelve tubercles more conspicuous. The pupa also has the anal cavity smaller, more closed, but deeper; and the prothoracic spiracles less prominent. In these respects it agrees more closely with the typical *carnaria*, as described by Packard, and I have little doubt but all these differences are simply varietal.

per kilogram, or other measure, is always offered by the government whenever agriculturists suffer from invasions. When we consider the number of persons rendered destitute in Kansas, Minnesota and Nebraska, by the invasions of 1874, and the danger of immense damage in 1875, from the issue from the eggs which in many places fill the ground, it is surprising that the Legislatures of those States did not give the inhabitants of the ravaged counties at once the means of warding off misery and suffering, and guarding against future destruction, by offering a liberal price per bushel for locust eggs. Let us hope that, whenever such a calamity befalls those States again, something of this kind will be done.

Wherever the eggs were laid last Fall, I advised our farmers, where it was practicable, to plow deeply, so as to turn them under and bury them as far as possible. This destroys them either entirely or in great part, and if a few survive, the young hatch so late the next season, that their power for harm is much lessened; and the horses, also, in the ravaged districts, are in much better condition to plow in the Fall than they are likely to be in the following Spring. Care should be had not to bring the eggs turned under in Autum, to the surface again, by plowing the same land the following Spring; for, thus brought to the surface, the eggs would undoubtedly hatch.

When irrigation is practicable, as it is in some of the ravaged parts of Colorado, let the ground be thoroughly inundated for a few days, and the eggs will all lose vitality and rot. I have already shown that the eggs are laid, by preference, on the high and dry knolls and ridges, and never in low, moist ground; and experiments prove how soon they succumb to excess of moisture.

Just as excessive moisture is fatal to the eggs, so is excessive dryness, or direct exposure to the atmosphere, so that they receive alternately the direct rays of the sun and the rains and dews. Consequently, harrowing the ground where these eggs are laid, so as to break up the glutinous masses and expose the eggs to the influences mentioned, and to the more easy detection of birds, is to be recommended. Of course none of these measures, except the first, or collecting the eggs, are applicable on a large scale, except where the country is thickly settled and cultivated fields are abundant. Wherever hogs and cattle can be turned into fields where the eggs abound, most of these will be destroyed by the rooting and tramping.

3d—Next to the destruction of the eggs, the destruction of the young, wingless locusts, is most within man's power. Thus, much good can be accomplished by the use of a heavy roller, when the young hoppers first hatch in Spring, or late in the Fall, as they exceptionally do when that season is prolonged and warm. In meadows and prairies they may be destroyed by fire started in a circle around them; or they may be driven into windrows of straw or hay, and then destroyed by fire; for when these young are traveling they can be driven almost as easily as a herd of sheep. Mr. N. C. Meeker, of Greeley, Col., states that in this way the farmers there manage to save 50 acres of grain at a cost not exceeding $20. Their course can also be governed by beating with brush until the advance guard is turned, when the balance follow the leaders. Wherever there are running ditches on a farm, the young can be driven into these and then caught and killed in sieves or coarse sacks. This method is quite commonly employed in those parts of the West where irrigating ditches and canals abound. In locust countries it is also a quite common practice to drive the young into a heap against any converging barrier, and then to destroy them by bagging or crushing.

The attempts to protect the plants by sundry applications, such as strong salt water, air-slacked lime, carbolic acid, etc., have proved unsatisfactory; and from the collective experience of a number of intelligent farmers in Colorado, which I made it a point of obtaining in 1873, I feel that nothing is to be hoped for from such substances. In 1868 and 1869, I sent two large cans of cresylic acid soap to Mr. Stephen Blanchard, of Oregon, Holt county, to be tested as a means of protecting his vegetables; but he in the end concluded that nothing would avail. Paris Green, as used for the Doryphora, will doubtless kill such locusts as partake of it; but its general use on all the plants which these omnivorous creatures relish, is out of the question. However, there is yet room here for experiment, though, considering that in all historical times, the resources of many nations have been employed against Locusts without furnishing anything that will protect plants on a large scale—little hope can be entertained of discovering such a substance. Turnips of which they are especially fond, kohlrabi, carrots, and the like, may be saved when the insects come late; by cutting off the tops and covering the roots with earth—the tops making excellent food for milch cows. The earth should be removed again as soon as possible to prevent the rotting of the roots.

Where the means already suggested cannot be employed, there are yet two methods of destroying these young, namely: by catching them in hand-nets, such as entomologists use, and as were described in my 5th Report; and crushing them with broad wooden shovels attached at an oblique angle to some kind of handle.

Finally, as Mr. Snyder well shows, in his letter which I publish in the Appendix, most cultivated plants may be protected from the ravages of these young by good cultivation and a constant stirring of the soil. The young have an antipathy to a lose and friable surface, which incommodes them and hinders their progress; and they will always leave such a surface for one more hard and firm. I say, therefore, to those in the districts where the locusts hatch out: get your crops in early; employ some one or all of the means here indicated; get your neighbors to do the same; but by all means cultivate thoroughly. Let the local granges take the matter in hand, and by resolution oblige united action among themselves, at least, by establishing a fine or some other penalty, to be paid by any recusant and neglectful members. If the means here enumerated are adopted in concert over the more thickly settled portions of the threatened country, as in our own western counties, prospective injury may be averted, and the enemy be rendered comparatively harmless until the danger is passed. Two or three month's energetic work will suffice. Determination perseverence and united action must be the watch-words· With these, the people in the stricken counties will accomplish more good than would have been accomplished by the $50,000 which the Legislature refused them last winter. In the less thickly settled parts no human agency is likely to affect the pest, and we can only hope that Providence, by the different natural agencies known to be fatal to it, may act where man is impotent.

4th—The destruction of the winged insects when they swoop down upon a country in prodigious swarms, is impossible. Man is powerless before the mighty host. Special plants, or small tracts of vegetation may be saved by perseveringly driving the insects off, or keeping them off by means of smudges, as the locusts avoid smoke. Great numbers may be caught and destroyed by bagging and crushing as recommended for the new-fledged; but as a rule the vast swarms from the west will have everything their own way. Mr. Kelsey succeeded in saving many of his young forest trees in Kansas by perseveringly smudging and smoking them.

He gives his experience in the following words in the *Kansas Farmer*, Aug. 26, 1874:

At first we tried building fires on the ground, but it was not successful. The smoke would not go where we wanted it to. We then tried taking a bunch of hay and holding it between sticks, would fire it, and then, passing through the field on the windward side, would hold it so that the smoke would strike the grasshoppers. We would soon have a cloud of hoppers on the wing, and by following it up would, in a short time, clear the field. We have thus far saved everything that was not destroyed when we commenced fighting them, and while I do not give this as an infallible remedy, not having tried it sufficiently, yet it does seem to me, from what I have seen of it, that one good active man who would attend right to it could protect a twenty acre field or a large orchard. But to be successful one must attend right to the business.

Smoke and scare, and keep it up until the hoppers leave, and if they attempt to come again, be after them with your smoke. Give them no peace from morning till night.

Sweetened water will measurably protect plants when the insects are not too ravenous. The same is true of old hay which was extensively used to cover and protect favorite garden plants. One of the few effectual means employed against the winged insects last year in grain fields was to "rope" the fields. This was done by hitching each end of a long rope to a horse and then causing it to be dragged over the grain, thus disturbing the insects and causing them either to fall to the ground or fly off. If continued the locusts get disgusted and leave. While this, and all other methods, are futile as against the vast swarms which continue to drop down upon a country for days, it will prove useful against local swarms when they become fledged, or small swarms which may suddenly alight in restricted localities. They should be driven off as much as possible towards evening, because they then use their wings reluctantly, and they do great injury during the night.

SUGGESTIONS THAT MAY BE OF SERVICE.

In addition to the foregoing remedial and preventive measures to be taken in dealing with locusts, a few other suggestions occur which may be of advantage. The plants that can be grown which are unmolested by the pests and which will not, in all likelihood, suffer, have already been enumerated: those which are cultivated are principally peas and other leguminous species, castor beans, sorghum, broom-corn, tomatoes, sweet potatoes, etc. The locusts, are, as already stated, particularly fond of tansy, cocklebur, and Amaranthus, and especially of turnips: why, therefore, should these not be sown around a grain-field, and periodically sprinkled with Paris Green water, so as to kill large numbers of the young insects? These last will also congregate on timothy in preference to other grasses or grain, and a strip of timothy around a corn or wheat-field, to be poisoned in the same way, might save the latter. It is also currently supposed that the common larkspur (*Delphinium*) is poisonous to these insects, but how much truth there is in the statement I am unable to tell. In going through an oats-field the winged insects drop a great deal of the grain, which, when ripe enough, might at once be harrowed in so as to furnish a good growth of fodder that can be cut and cured for Winter use. The lesson of 1873 and 1874 should also not go unheeded. The former year was one of plenty, and corn was so cheap and abundant that it was burned for fuel in many sections where in 1874 there were empty cribs and the farmers wished they had been more provident.

Nothing, however, will so surely insure those States subject to them, against the ravages of this insect, as irrigation. With water at command, the farmer in all this locust area is measurably master of his two greatest insect plagues, and full master of the young locusts; and if there were no other reasons to be urged in its favor, these are sufficient to warrant those States included in said area, in using all means in their power in having schemes for irrigation perfected and carried out as far as the topography, soil, and other peculiarities of the country will admit.

Finally, in cases where, as in some parts of Kansas and Nebraska last Autumn, famine stares the people in the face, why should not these insects be made use of as food? Though the question will very generally cause the reader to smile, and the idea will seem repugnant enough to the tastes of most, I ask it in all seriousness. It is to be hoped that none of the people of this grand and productive country will ever be reduced to the diet of John the Baptist; but it should not be forgotten that the locusts may be made use of as food; that they are quite nutritious, and are, indeed, highly esteemed by many peoples. I do not intend in this connection to write an essay on edible insects, though a very curious and startling one might be written on the subject; but I wish to insist on the fact that in many parts of Asia and Africa subject to locust plagues, these insects form one of the most common articles of food. Our own Snake and Digger Indians industriously collect them and store them for future use. Deprived of wings and legs, they are esteemed a great delicacy fried in oil, or they are formed into cakes and dried in the sun—sometimes pounded into flour, with which a kind of bread is made.

Love or dislike of certain animals for food are very much matters of habit, or fashion; for we esteem many things to-day which our forefathers either considered poisonous or repulsive. There is nothing very attractive about such cold-blooded animals as turtles, frogs, oysters, clams, crabs, lobsters, prawns, periwinkles, snails, shrimps, mussels, quahaughs or scallops, until we have become accustomed to them; and what is there about a dish of locusts, well served up, more repulsive than a lot of shrimps: they feed on green vegetation and are more cleanly than pigs or chickens. Who can doubt but that the French during the late investment of Paris would have looked upon a swarm of these locusts as a manna-like blessing from heaven, and would have much preferred them to stewed rat? And why should the people of the West, when rendered destitute and foodless by these insects, not make the best of the circumstances, and guard against famine, by collecting, roasting and grinding them to flour? Surely, with modern cookery they can improve on the Digger Indians in making a locust dish that shall be attractive and palatable even to those not predisposed from sharpened appetites, to judge favorably; and in any event it would pay under such circumstances to roast and preserve them as food for poultry and hogs.

NOMENCLATURE.

Regarding the popular name of our insect there is great lack of uniformity in the terms by which it is designated, and many of the readers of this Report who have been accustomed to hearing these insects very generally called "grasshoppers," will doubtless wonder why I have not followed common usage. The term "Grasshopper" is very generally employed for these insects in America, but should be abandoned for that of "Locust," which is applied to similar species in all other parts of the world, the "locusts" of Scripture being very closely allied species. As I have already said, (6th Rep. p. 153, note):

It is to be regretted that American entomolgical writers do not more strictly follow Harris in conforming to the English custom of calling these insects—with short antennæ and stridulating by means of the stout hind legs—by the popular term of "locusts," which is in the keeping with ancient usage. The term "grasshopper" would then be confined to the long-horned and long-legged, green group, stridulating solely with the wings, in which the species are more solitary and never congregate in swarms, and in which the female is invariably provided with a sword or cimiter-shaped ovipositor; while the term Katydid could be used to designate the few larger, tree-inhabiting species of the group, so designated by Harris. Where the habit of calling the Cicada "Locust," and the "Locust" of ancient usage "Grasshopper," is as inveterate as in this country, it is not easy to change it; but it seems to me that the change is desirable, and if popular authors would only continue the example of Harris, the change would come about with the greater dissemination of entomological information.

Almost every entomological author has been under the necessity, at one time or another, of insisting that the "Grasshopper" of this country is the "Locust" of Europe and of antiquity; or of endeavoring to clear up the confusion which results from the popular application of this last term to the Periodical Cicada or Harvest-fly—an insect (Fig. 40) which dwells, in its early life, under ground, and feeds by sucking the sap of trees, and which is no more capable, like the true locust, of devastating our grain-fields than a calf is of killing and devouring our sheep. Yet the ceaseless preaching about the popular misapplication of these terms in America will avail nothing so long as the popular error is encouraged by the preachers themselves adopting the misapplication. The popular names of a country should be respected as much as possible, especially for objects peculiar to the country, and I would be the last to try and change them

[Fig. 40.]

CICADA, or miscalled locust: with one wing removed, so as to show the beak and vipositor.

for trivial reasons; but when, as in this instance, the name used for centuries in the older countries, and become familiar as household words through the widely disseminated Scriptures, is substituted by a new one, and transferred to an entirely different insect, there is no excuse for perpetuating the popular error.

We may talk of *shipping* a car-load, and of the *sun's rising*, from now till doomsday; and, though, to the intelligent and hypercritical mind the expressions will ever savor of incorrectness; no one is foolish enough to try and reform them, because they are universal, wherever the English language is spoken. Change in universal and long established customs is neither possible, as a rule, nor advisable; and it is doubtful if any reform could be brought about in our present Gregorian calendar, for instance, even if the advantage of regulating the divisions of the year by the astronomical conditions of the earth's orbit could be fully established. But in a case like that between the use of the terms LOCUST and GRASSHOPPER, the former, as applied to our Rocky Mountain plague and its allies, has every claim to favor, not only because of having been longer used, and of its now being more universally used than the latter; but because it has a definite meaning and agrees with the old systematic name of the family to which the species belongs; while the term "grasshopper" is most loosely applied to almost every field insect that hops. The term locust is, in fact, supposed to be derived from the Latin words *locus ustus,* which mean a burnt place, and have reference to the desolation, as if by fire, which these insects cause.

The trivial terms "Colorado," "Red-legged," and "Hateful" have been applied to the species by various writers; but the name "Rocky Mountain Locust," which I have employed, is expressive of the insect's habitat and least open to objection.

Regarding the scientific name of our insect, it is only necessary to add in addition to what has already been said, that it belongs to the modern genus *Melanoplus* of Stäl; but just as this author's subdivisions of certain genera in Coleoptera are not accepted or recognized by many of our best coleopterists, so *Melanoplus* is not considered as of generic value by some of our best orthopterists; for which reason I have used the better known and well established genus *Caloptenus*. The specific name *spretus* (meaning despised) indicates that, as a species, it was so long overlooked by entomologists, and confounded with *femur-rubrum*.

PRAIRIE FIRES vs. THE ROCKY MOUNTAIN LOCUST.

The notion has got into the heads of a good many people, that there is some connection between prairie fires and the Locust visitations. Having already discussed the subject in the columns of the New York *Tribune*, I will here repeat what I there said:

The *Kansas Farmer* for September 23d last, contained a lengthy and hortatory article on the effects of prairie fires. The burden of the article was to prove that all misfortune that had befallen the fair State of Kansas was in one way or another attributable to the custom of burning over the prairies. In the words of the writer: "The unbroken succession of curses that have afflicted this and neighboring counties * * all spring from the one first grand cause, the burning of the prairie grasses," and he then goes on to demonstrate, as he believes, that burning the grasses from the face of the earth had been the one great cause of drouth, hot winds, locusts and short crops. The drouth, hot winds, and grasshopper raids of 1860 are attributed to the universal burning of grass in 1859. The short crops of 1864, the locust invasion of 1866, and the bad years of '68 and '70 similarly find their explanation in said article, in the burning of the grass, now attributed to Indians desirous of driving their buffalo herds westward, and of putting between them and the troublesome frontier hunters a "wide, black and impassable waste"—now to the Texan cattle traders who, on their way home from Abeline, fired the prairies on all sides, so that it was burned off "from the North pole to the Gulf of Mexico." The disasters of 1874 were confessedly not preceded by such general conflagrations, but the reduced snow-fall in the mountains is made responsible for that portion of the 1874 disaster which prairie fires did not produce.

The writer then goes on to state some well-known principles of radiation and to explain that all simoons or hot scorching winds have their origin in desert countries, and that "it matters not whether the country is an original desert or whether it is made so by the action of our Western prairie fires. For all present purposes the two are reduced to a common level, and produce a common result—drouth, hot winds, and locusts." Having thus traced the cause of drouth to prairie fires, the article goes on to show how the locusts are a consequence of drouth. The author first asserts that the State has never been "visited by these destructive locusts except during seasons of drouth and hot winds," basing his assertion partly on the fact that Kansas never suffered from these insects during fruitful years. I cannot say how well founded is the assertion, but the latter statement is a simple truism not necessarily proving the assertion. When we remember also the number of drouthy years that have not been succeeded by locust invasions the assertion loses much of its force. As a single instance, let us recall the unprecedented drouth of 1871. This was not preceded, that I am aware of, by any unusual number of prairie fires; but it *was* the indirect cause of most remarkable and destructive conflagrations all over the Western country during the Fall of the same year. Nor was it succeeded by locust invasions, as it should have been were the position of the writer in the *Kansas Farmer* well taken.

The reason given why the locusts can only come in drouthy seasons, is, that they cannot fly in a moist atmosphere, and the facts that they do not readily fly early in the morning, and that the farther east you go, or, in other words, the more moist the atmosphere becomes, the insects diminish in number and consequent power for harm. In further support of this view, it is asserted that at Kansas City, "where two rivers connect with their wide belts of timber shade, with an old settled country surrounding them, so that prairie fires cannot exist, we find no locusts." The author having proved, in this manner, and to his own satisfaction, the connection between burning grass and locusts, closes with a graphic picture of what might have been had misfortune not frowned upon the people, and an earnest appeal to the former—not in one township or section, but over the whole State—to cease burning the prairie, as the only radical cure for all these evils. Now, if he has reasoned well, it is of the utmost importance for the people of Kansas to follow his advice, and the subject is, consequently, well worth a little attention. I will, therefore, give my reasons for believing that while some partial truths have been stated in his thesis, the general conclusions are false and misleading:

1.—It is by no means proved that the simoons which occasionally sweep over our Western States and Territories have their origin in any part of that vast prairie country. Some of the more local of these hot, dry winds may originate or acquire their peculiarly high temperature on the mauvaises terres of Wyoming or the table lands of Arizona and Mexico; but the more general simoons most probably have their origin at a far greater distance from us, viz., in the tropics. These simoons in Missouri always blow from the southwest, in Kansas from south, southwest, and in Eastern Colorado south.

or a few points east of south; and their injurious and scorching effects are not unfrequently felt before the frost in Kansas and the country to the west is fairly out of the ground. 2.—It is well known that the buffalo grass ranges over a vast extent of our Western plains, and that it does not furnish a very dense or thorough covering, even when unburned. 3.—My own observations for the past fourteen years in this Western prairie country lead me to the conclusion that fires more often succeed than precede drouth, and that they may more justly be looked upon as a result than as a cause of excessive dry weather; and the prevailing belief that large conflagrations or extensive fires are conducive to rain, bears on this point. 4.—Whenever grass is burned during the growing season, the old and drier blade is soon succeeded by a green and succulent one, which has far greater power to attract and retain moisture; while if burned in Winter time the evaporation from the soil can be thereby but slightly affected, because of the weakened power of the sun, and the snows which usually cover and protect. 5.—Drouths are by no means confined to that portion of the country subject to the locust invasions. 6.—The reason why locusts are more sluggish and less inclined to fly at morn than at noon is not so much a question of the comparative density of the atmosphere as of the difference in temperature. All diurnal insects are sluggish in the cool of the morning, and their activity increases with the rising of the thermometer; and flight, whether of bird or insect, is, I conceive, easier, *cæteris paribus*, in a dense than in an attenuated atmosphere. 7.—The reason why the Rocky Mountain Locust does no damage in the Eastern States, and never reaches beyond a line drawn at a rough estimate along longitude 17° west from Washington, is, I take it, rather because, first, there is a definite limit to its power of migration from its native home in a single season; second, because the new conditions which it meets with in the lower country forming the eastern limit, injuriously affect it and kill it off in the course of one or two years. 8.—The statement about the Kansas City region is simply incorrect, as the locusts were thick around that city the present year. 9.—As the Rocky Mountain Locust multiplies only in the Rocky Mountain region, its descent into the plains to the East where it cannot thrive, cannot well be affected by the burning of the grass on those plains.

Having thus given some facts which militate against the conclusions arrived at in the *Kansas Farmer* article, let us now consider, as a still farther offset against those conclusions, the benefit resulting from the burning of prairies. Fearful as are the ravages of locusts, they are only periodically as general and widespread as they were the present year, and if we consider the annual damage done to the crops of Kansas by any one insect, the Chinch Bug must, I think, be set down as a greater enemy to the Kansas farmer than the Hateful Locust. Even this year, in the eastern portion of that State, the chinch bugs, aided by the excessive dry weather, had so depleted, by their myriad pumping beaks, the later ripening cereals, that these would have made but a very poor return for the labor spent upon them, even had the locusts not made their advent. Now there are no better preventive measures against the injuries of the Chinch Bug than the burning of the grass on our prairies and around our cultivated fields, and the destruction, by the same means, of weeds, leaves, corn-stalks and all other litter and rubbish around such fields, and as far as possible within the woods. For the Chinch Bug hibernates under just such shelter as this litter affords, and the proper season to attack it is in the Winter time, and not at or just before harvest, when it, in great measure, baffles human control.

This statement might be substantiated by a long list of facts in the insect's economy, which it is unnecessary to mention here, and I will simply add in testimony that in Illinois, before the country was as thickly settled as now, and when immense fires annually swept over her prairies, the ravages of the Chinch Bug were scarely known. It is therefore very patent that the judicious burning of the dead grasses, especially in the vicinity of cultivated fields, will reduce the ravages of this worst of the farmer's pests, and the same will hold true of the False Chich Bug (*Nysius destructor*), which affects our garden vegetables and other tender-leaved plants in the same way as the genuine Chinch Bug affects our cereals. It is also true of many other destructive insects which shelter under dead grass and herbage during the Winter. But, most important of all, it is also true of the young locusts and of locust eggs, immense numbers of which undoubtedly get destroyed by such fires. A strong impression also prevails among farmers, and it is not without foundation, that the burning of our prairies is beneficial in that it returns at once the potash of the plant to the soil, instead of through the slower process of decomposition. From these premises I think we may safely draw the following conclusions:

1.—That the non-burning of the prairies will not prove a cure for all the ills that Kansas is subject to. 2.—That, on the contrary, the judicious burning of such prairies will prove a measurable cure for some of her most serious ills. Indeed, there is only one way in which there can be any real connection between the burning of prairies and the ravages of the Rocky Mountain Locust, and that connection is through the remote past, and altogether beyond our present control. In the report of the Chief Signal

Officer to the War Department for 1872, will be found an interesting account of the great fires of 1871 in the Northwest, by Prof. J. A. Lapham, of Milwaukee, Wis., in which my learned friend maintains that our extensive Western prairies and plains owe their existence and origin to the agency of fire. These fires, encouraged by drouth, and either kindled by accident or intention, have swept over the country for ages, and while they leave the roots of the grass uninjured, they destroy the germs of most other plants, including forest trees; and Mr. Lapham pictures to himself a long-past struggle between forest and prairie, in which the latter, by the assistance of the Fire King, has gained and held the vantage ground.

While I do not agree with Prof. Lapham that the remote cause of our prairies can be attributed to fire, yet no one can doubt its agency at the present time in maintaining these prairies and preventing timber growth in the more humid portions of the great prairie region. But on this hypothesis there would naturally be a connection in the past between fires and locusts; for if without fires this whole prairie region had been timbered, the locusts, which are essentially insects of the plains and prairies, could never have become so prodigiously abundant and injurious. On such a hypothesis alone can I see any possible connection between prairie fires and locust invasions, and, however much truth there may be in the hypothesis, the fact remains that there is no present connection between the two phenomena.

APPENDIX

TO THE

ARTICLE ON THE ROCKY MOUNTAIN LOCUST.

The length which this Report has already attained precludes the publishing of any of the many answers to my circular from the different counties of Missouri. There is so much valuable experience, however, in the following letters, by three valued and intelligent correspondents, from Texas and Kansas, that I feel constrained to publish them entire, as a fitting sequel to what I have said on the Rocky Mountain Locust:

Letter from the late Thos. Affleck, of Brenham, Texas, written in 1868.

About the first week of November, 1867, locusts appeared here, but were announced towards the northwest of us as being on the way some weeks before. They came down from a considerable height in showers about like a fall of snow—their silvery wings contributing to the resemblance. On looking toward the sun, they could be perceived in vast clouds, at a great height, and all steering to the southeast.

They were busily engaged devastating the crops about Union Hill, five miles to the west, for a week before they made their appearance here, and were nearly two weeks longer in reaching Brenham, seven and a half miles to the south-by-east. They were very few in number to the south and east of that town.

Immediately on alighting, they began to devour every green thing, possessing ravenous appetites; and also copulated in great numbers, after which the males gradually disappeared. As food failed them, they would occasionally take to wing in small bodies and go off; but generally "took it afoot" in search of fresh pastures. Everything green in the gardens, turnip patches, wheat-fields, etc., was devoured; and much of the Winter or Prickly Mesquit Grass (*Stipa setigera*) so as greatly to lessen the weight of pasturage, and stint the stock.

When I reached home, about the first of December, they were busy depositing their eggs, and had been so for some two or more weeks before. The female selected high and dry spots, and especially little ridges of hard ground on paths, roads and beaten yards, formed by the washing of water.

They were preyed upon by birds, animals, and other insects. What few hogs were hereabouts, devoured them greedily, as did poultry; they gradually disappeared without being able to say how.

We had some very bad freezes for this latitude, the ground being frozen to a depth considerably below the nests of eggs; and this more than once freezing and thawing during the Winter. We were in hopes that this would have destroyed them, and in rich, black, prairie soil, many thus perished. But enough were left to produce untold myriads of the pests. They began to hatch early in February; when first seen, they were about the size of a big flea; but a few continued to appear for six weeks or more. I perceive, from my "Jottings on the Farm," in the *Houston Telegraph*, that on the 28th of March they began to move—having hitherto fed about close by where they were hatched—though only about five-eighths of an inch in length, and without wings.

I quote from these jottings: "My garden is located on rich, stiffish valley land, and, by the way, is in a very promising condition. Until yesterday there was not a Locust within the twenty acre lot, of which my garden now forms a small part. But two days ago, the *varmints* began to move, on their 'nor'-west coorse,' and accumulated in fearful numbers along the east and south lines of the fence. Strange enough, however, they did not seem inclined to cross over, which they could easily have done by hopping through between the rails. After a day or two of hesitation, they made a fresh start yesterday morning, and poured in on me in myriads. By night, I should say, at a rough guess, that about one hundred bushels, more or less, if carefully measured up, were within the limits of these twenty acres! They took a line diagonally across, hopping along at a rate that would take them over the ground about a mile per day. They present a very singular appearance indeed; not one diverging from 'the way they should go,' or are impelled by their instinct to go. The advance soon struck the north line of the fence; vast numbers, still behind, made no movement beyond a certain strip of prairie sod, left as an intended carriage drive. But, instead of crossing it, they followed it down; clipping the leaves partially from a nice young hedge of Marietta rose, and threatening the potato patch. I could not stand *that*. So, taking a branch in each hand, I hurried them up, at the same time fending them off from the potatoes. They submitted to be driven quite as readily as a flock of sheep, so that I still hope to save my garden."

"April 3. These locusts have taken possession of a young orchard of Peach and Almond, and of a lot of fine dwarfed Pear trees (of many varieties, and about eight feet in height, full of blossom) which were very promising. They *roost* on the trees at night; breakfast on the leaves and young fruit, before lunching and dining on the grass and buds. Yesterday I could not drive them, and to-day the ground is so wet they won't be driven. And, worst of all, the bulk of them are to the southeast of my vegetable garden."

"April 11. Still keeping up the fight with the locusts. I fought with fire; drove them into the stream of water, and in every way in my power, helped them on their way or destroyed them. A large flock of blackbirds came to my assistance, and did great service. They are now nearly gone, and I hope will soon take flight.

"April 18. I have been consoled to-day with the assurance that there are more locusts in this valley (Glenblythe) than anywhere else in the county.

"April 23. Vast numbers of the locusts have gone off, leaving only those of tender age, but possessing wonderful appetites. Some of them got off by flight, but the bulk kept on, on foot, towards the northwest, followed and preyed upon by hundreds of Black Hawks, or rather Buzzards, I think the *Falco Harlani.*

"April 29. Still a few left, but no more than the poultry and I can manage.

"I saved about two-thirds of my garden; but by constant toil.

"None copulated before leaving, and of course no eggs were left to perpetuate the curse, and it may be many years before they again visit this now sufficiently oppressed country.

Letter from Mr. S. T. Kelsey, Hutchinson, Kans., Forester to the Atchison, Topeka and Santa Fe R. R. Co.; written August 5, 1874.

The migratory grasshoppers (*Caloptenus spretus*) have again appeared in Kansas, and I hereby send you a report of their operations as I had promised. I first saw them at Hutchinson, on the Atchison, Topeka and Santa Fe Railroad, where they appeared on Sunday, July 26, at about 6 o'clock P. M. They were so thick in the air that they appeared like a heavy snow storm; those high in the air forming apparently light fleecy clouds, while those dropping to the earth resembled flakes of falling snow. Next morning, Monday, the 27th, at daylight, the country was literally covered with grasshoppers. Soon after sunrise, they collected on the growing crops, young trees, etc., and commenced eating, and before night had eaten the leaves from almost every green thing. All that I know of their leaving unhurt is sorghum, castor beans and honey locust trees. They did but little harm in most places to the cottonwood, box elder, Osage orange, elm, black walnut and oak, and such prairie weeds and grasses as were a little dried. They have worked some upon every tree that I have, except the honey locust. In some places, they have eaten the leaves, bark, and even the wood of the one and two year growths. On Tuesday morning, the 28th, I went west on the Atchison, Topeka and Santa Fe Railroad, and found that the grasshoppers reached the Arkansas Valley, as far west as Larned, on Sunday evening; on Monday, they appeared as far west as Pierceville; on Tuesday, as far as Aubrey; and on Wednesday, at 2 P. M., they appeared in force at Granada, Col., the terminus of the Atchison, Topeka and Santa Fe Railroad. I am told by persons who have come down the Kansas Pacific Railway that they extend on that line from Junction City, Kans., to Denver, Col.—a distance in direct line of about 450 miles. I have not been able to learn whether they extend west of Denver. They seem to be moving a little west of south—the first of the column occupying, as near as I can learn, nearly a straight line, at about right angles with the direction they are moving. The wind appears to change their course a little, but, I think, not very much.

They strip the country as they go, except the old, tough grasses and some things I noticed before, and then rise and fly—probably to the front of the column. I am not able yet to ascertain certainly how wide the column is, but it must be 200 to 300 miles in width. They are doubtless the same that have been destroying the crops of Western Iowa and Minnesota, and from the notes that I get from the north, I expect they have, in their course, destroyed all the growing crops of Central and Western Nebraska, as well as Kansas. They have not commenced to copulate yet, and will likely pass down into Texas or New Mexico to deposit their eggs.

I was told yesterday, by parties just from the north, that another column was moving down farther east, and taking a more easterly course, and would, if they kept on, strike through Eastern Kansas; however, I do not believe the story. Will post you if they do come. I learn from reports, and from parties who have traveled in British America, that they breed far up into that country, and as far south as Mexico. Thus it appears that nearly one-half of all the territory of the United States, excepting Alaska, is subject at intervals to the devastation of this migratory grasshopper, and it seems of great importance to the people of the West and the whole country that we should get all possible information respecting them, and the best means for destroying them or preventing their ravages. I am looking the matter up, and any further information that you may desire will be cheerfully given, so far as possible.

I am told that some fields of corn have been saved by building fires so that the smoke would pass over the field, and the grasshoppers would get up and leave on short notice.

Letter from Mr. E. Snyder, Nurseryman of large Experience at Highland, Kansas, written January 11, 1875.

The first appearance of the Rocky Mountain Locust, more commonly known here as Red-legged or Army Grasshopper, in this section of country, was about the 10th of September, 1866.

People who have lived here forty years, say this was the first time these grasshoppers made their appearance to their knowledge.

At our place they commenced coming down about 1 o'clock in the afternoon, at first only one at a time, here and there, looking a little like flakes of snow, but acting more like the advance skirmishers of an advancing army; soon they commenced coming thicker and faster, and they again were followed by vast columns, or bodies looking almost like clouds in the atmosphere. They came rattling and pattering on the houses, and against the windows, falling in the fields, on the prairies and in the waters—everywhere and on everything.

By about 4 o'clock in the afternoon, every tree and bush, buildings, fences, fields, roads, and everything, except animated beings, was completely covered with grasshoppers. When they first alighted, they seemed exhausted, but it did not require much time for them to recover and become familiar with their new surroundings; they almost immediately commenced devouring and destroying plants with a voraciousness and rapidity truly astonishing to one not acquainted with them.

After about 4 o'clock few could be seen flying, except when disturbed, or making short trips probably in quest of food. They seemed to be inclined towards dry, warm places for the night, and all such places were packed and crowded by the time the sun went down.

They commenced depositing eggs almost as soon as they arrived, and the earth in many places presented the appearance of honey-comb, being caused by the boring or perforating process of these insects, preparatory to the depositing of the eggs. In this they showed a decided preference for hard, warm, dry places, such as roads, new breaking of prairie sod, etc., often selecting places so hard that it was difficult to penetrate the ground with a spade or sharp pointed stick; shady, moist places were partially avoided, although almost every spot of ground secured some.

The grasshoppers remained, and continued depositing eggs until after hard frosts, but became less abundant, and of less vitality, as cool weather and frosty nights approached. There was considerable rain during the Fall, and the hopes and predictions were that the wet weather would destroy the vitality of the eggs, and many thought their coming a mere accident, the first time they were ever here, and they would not trouble us any more

As cold weather came on, they collected more toward warm spots; wagon roads and railroad tracks, being warmed up during the day by the heat of the sun, were completely covered, and as they seldom move at night, the morning after found them stiff and numb, especially on the iron rails, from which they could not move until the sun warmed them up again, and railroad trains often had difficulty in getting up the grades on account of the wheels and track getting slippery, which gave rise to the story that "grasshoppers were so thick they stopped the cars."

Whatever our calculations may be, nature works according to laws we cannot change, and accordingly the following Spring we had a practical demonstration whether the eggs deposited the previous Fall would hatch or not. Although the Fall had been quite wet, with considerable rain in the Spring, and freezing and thawing in the interval, the eggs seemed to be proof against any kind of weather, and myriads of young grasshoppers hatched out as soon as the weather was warm enough. About the latter part of April and first of May appeared to bring forth the great bulk of them. They were apparently harmless little mites at first, but as they grew older and larger their voraciousness increased, and when nearly grown their destructiveness was alarming, and could only be understood by those beholding it. The young grasshoppers could not fly; but during the month of June, commencing about the first, they divested themselves completely of an outside skin, even unto the legs and feet, and came out a winged insect, and soon thereafter took their flight and left us.

In the month of September following (1867) they came down again, but not so many as the previous year. They again deposited eggs, but not in such vast quantities as before. A large proportion of the grasshoppers had attached to their wings or other portions small red insects, and also contained inside of them small white worms or maggots.

The Spring following (1868), the eggs again hatched out, but they were more under control of their various enemies, and the damage inflicted was not so much nor so general as the previous season, and they became infested with mites and worms before they flew away in June.

The next appearance of these pests was in August, 1874, and this invasion is still fresh in the memory of nearly every one familiar with the name of Kansas or Nebraska.

They have their preference for certain kinds of food, but in the absence of what they like best will eat almost anything. I have known them to eat the outside off of fence posts and boards, and other weather-beaten timber, until it looked as if the outside had been hacked or chipped off. I have had all the foliage and bark, and the ends of twigs, eaten off of young trees by them. Soon after coming down, they commence moving around, something like the foragers of an army, and soon gather and collect on such things as they like best in great numbers. Almost all the ordinary crops of the farm and garden seem to be desirable forage for them; but among the things that are most eagerly devoured are cabbage, onions, radishes, etc. I have frequently seen onion and radish beds with nothing left but the holes in the ground where they grew, having been eaten clean out. I have succeeded in raising tomato plants, but the ripe tomatoes are generally eaten. Apple and pear trees are stripped of foliage, and sometimes part of the bark; but the fruit is not often eaten, but left hanging on the trees. The foliage of peach, cherry and plum trees generally escapes, but the fruit, especially peaches, is generally destroyed, leaving the pits hanging on the trees. Willows and poplars soon become stripped of foliage—the tall Lombardy poplar sometimes looking like an immense swarm of bees, being almost covered with grasshoppers from the top to the ground.

While few vegetate things of value as food for people escaped without damage, there was a very noticeable difference in the amount of injury the same varieties of trees or plants sustained under different circumstances. For example: One tree or plant out of a number of others of the same kind might be entirely destroyed or devoured, while all the rest would be but slightly injured, or part of the same lot would be badly injured, and part but slightly. Upon examination it was always found that when this difference occurred, it was due to a decline in the vitality of such trees or plants as were mostly injured. It was quite noticeable that newly transplanted things were more subject to being fed upon than well established ones; that any tree in an orchard of the same variety that was injured by borers, excessive bearing, or from other causes, would be entirely stripped of foliage, while the others would not. And even in corn-fields, where plowing was done so as to injure the roots and cause the corn to wilt, they left the more vigorous growth and attacked the injured. I have observed a number of them get around the base of a growing corn-stalk an inch in diameter, and gnaw it off close to the ground, like a lot of beavers gnawing off a tree; and as soon as the corn fell to the ground, there was a rush for it by others that seemed to be in waiting, and the fallen stalk would disappear at an astonishing rate.

Of course they do not confine themselves to this kind of diet, and yet they seem to prefer it, as is shown in the eagerness by which they feed upon any vegetable growth that is wilted or on the decline. They show this disposition towards their own family, for whenever any of them get killed or disabled, others go to work and eat them up, the one being devoured by the others will kick and struggle as long as life remains, (and they have a wonderful tenacious life,) but it is all of no use, the length of life only depends on how long it will take the others to eat it up. Young plants just coming from the seeds, being weak and easily destroyed, are also particular objects of the tastes and appetites of these insects.

Having learned that their favorite places, or their resorts of choice, are hard, dry, warm places, and their preference in food such as is not strongest in vitality, the remedies most successfully employed against them here are early planting, good and thorough cultivation, and the production of thrifty and vigorous growth in crops.

In wet or cool weather they are comparatively harmless, being scarcely able to fly or eat; in clear weather the air is filled with them, (after they commence flying); in cloudy weather few can be seen flying, and on wet or rainy days they do not fly at all.

Their habits seem to be restless and migratory; they show this disposition as soon as they hatch out in the Spring, first collecting on patches of May-weed and smart-weed, and other things suited to their tastes and natures. They will move in bodies from one point to another in search of food to suit them. While young, and before they have wings to fly, they move in a peculiar manner, by walking a short distance and then jumping. In their travels they prefer hard ground, as it is somewhat difficult for them to travel (walk and jump) on loose ground. Thus it is that corn-fields of considerable size, when well cultivated, generally escape destruction, especially if the corn gets a good early start in growth. And I think there is no doubt but that a continuous and thorough working of ground by horse power, is a good safeguard against these insects from the time they hatch out until they fly. It may not be practical to save small tracts or lots of ground in this way, because they may encircle from all sides and over-run it.

I am one of those who believe there is a final remedy for every evil, and to know how to overcome them is simply a matter of time and study, and we may as well get right to work and prepare ourselves to meet and overcome, as well as we can, every calamity and misfortune that is likely to come in our way.

That the insect in question is one of the greatest scourges this splendid country is subject to, too many have the misfortune to know, and the past gives but little reason to hope we will not be troubled with them in the future, unless some organized practical method be adopted to destroy their power for harm.

INDEX.

ERRATA.

Page 5, line 16, for "State" read "state."
Page 7, line 7, for "calubrine" read "colubrine."
Page 17, last line, note, for "Dep. de l'Hèrault" read "Dép. de l'Hérault."
Page 21, line 14 from bottom, for "Lencopterus" read "Leucopterus."
Page 39, under Fig. 6, for "TTIM" read "TRIM."
Page 80, under the heading, add "(Ord., LEPIDOPTERA; Fam., PHALÆNIDÆ.)"
Page 90, under the heading, add "(Sub-ord., HOMOPTERA; Fam., APHIDÆ.)"
Page 94, in the sub-head, for "gall-inhabiting" read "root-inhabiting."
Page 124, line 10 from bottom, for "*Coloptenus*" read "*Caloptenus*."

EIGHTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL,

AND OTHER

INSECTS

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY:
REGAN & CARTER, PRINTERS AND BINDERS.
1876.

PREFACE.

To the President and Members of the State Board of Agriculture:

GENTLEMEN: The following pages constitute my Eighth Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri.

The year 1875 was notable in the annals of our State by the ravages of two insects more particularly, viz.: the Army Worm and the Rocky Mountain Locust, and the present Report is, consequently, largely devoted to them. Of the former species I have been fortunate enough to ascertain, by direct observation, the mode, place and time of oviposition, which have hitherto remained unknown, notwithstanding the insect is at times so very abundant and destructive, and notwithstanding that on our knowledge of when and where the eggs are laid, depends our most successful and simple means of preventing its injuries. I have deemed the matter of sufficient importance to delay the closing of the Report in order to add some supplementary notes, giving an account of the eggs and of the early stages of the worm.

On the Rocky Mountain Locust I have dwelt at length, embodying the dear-bought experience of the year. The fearful ravages of this pest and the destitution and suffering which it caused in our western counties, in the Spring of 1875, are too fresh in the minds of our people to need further notice. They warrant the large amount of space devoted to the subject in the following pages; and I trust that in the event of a repetition of such visitations as those of 1874 and 1875, the record of experience, the suggestions and recommendations in this and the preceding Report, by being placed before our farmers in available form for reference, will enable them to successfully cope with the enemy and avoid the loss and suffering experienced the past year. I would especially call the attention of the members of our next Legislature to what I have said on pp. 32-40, where I hope that the necessity for some action on their part is demonstrated.

It is gratifying to know that my conclusions and predictions published last Spring were justified by subsequent events, and, so far as we can judge from the indications, it is shown in the following pages that our farmers are not likely to seriously suffer during the year 1876 from any of their three worst insect enemies—the Army Worm, the Chinch Bug and the Rocky Mountain Locust—and I hope that the apprehensions that exist, regarding this last more particularly, will be allayed by what I have recorded.

Once more I must refer to the inconvenience of having these Entomological Reports bound in the same volume with that of your Secretary. Instead of being distributed in April, when it was out, and when the information contained in it was most being sought for, my last, as I am informed by the Secretary of State, was not sent out till into the Fall. From a small, separate-bound edition, which I always have published and sent out at my own expense, it was noticed, and extracts were made from it, both at home and abroad soon after its completion; but the fact nevertheless remains that it was not distributed among our farmers till long after many of them had applied for it; and the only way to avoid such difficulties in the future is to have the two reports separately bound.

As it is frequently advisable to give to the public facts to be embodied in these Reports when they are yet fresh and most useful, I have chosen as media for so doing the New York Weekly *Tribune* and *Colman's Rural World* more particularly, so that some of the matter in the present Report has already appeared, generally over my own name or initials, in the columns of those journals.

In this, as in the previous volumes, when the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, or in works out of print or difficult of access, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. I have endeavored to give a popular name to each insect of economic importance, and this is invariably accompanied, wherever accuracy demands it, by the scientific name, and the latter is generally printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, are also given under each heading. The dimensions are expressed in inches and the fractional parts of an inch. Where so small, however, as to render such measurement inaccurate, I have adopted the milimeter—one milimeter (1 mm.) not quite equaling twenty-five hundreths of an inch (0.25 inch.) The sign ♂ wherever used, is an abbreviation for the word "male," the sign ♀ for "female," and the sign ☿ for neuter.

Some of the figures are enlarged, but the natural size of each of such is also given or indicated by a hair-line, except in the representation of enlarged stuctural details, where they are connected with the life-sized insect to which they belong.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted the following plan: When the specific name is coupled with the generic name under which it was first published, the describer's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is enclosed in parenthesis thus—*Acrobasis nebulo* (Walsh;) except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g. (*Acrobasis nebulo*, Walsh.)

All the illustrations, unless otherwise stated, are drawn by myself from nature.

My office is still at Room 42, St. Louis Insurance Building, N. W. Corner of Sixth and Locust Sts., where all communications should be sent. I tender my cordial thanks to the officers of the Iron Mountain, K. C. & Northern, and Mo. Pacific Railroads, for courtesies extended, in the way of passes, over their respective lines.

Respectfully submitted,

CHARLES V. RILEY,

State Entomologist.

ST. LOUIS, MO., May 15, 1876.

TABLE OF CONTENTS.

INNOXIOUS INSECTS.

NOXIOUS INSECTS—*Continued.*

NOXIOUS INSECTS.

THE COLORADO POTATO BEETLE—*Doryphora 10-lineata* Say

(Ord. Coleoptera; Fam. Chrysomelidæ.)

In accordance with previous custom, I herewith record such notes on this insect as are suggested by the past year's experience with it and as are deemed of sufficient interest.

DAMAGE DURING THE YEAR.

The summer in Missouri was so excessively wet that although the beetle was abundant enough in the spring it subsequently became comparatively scarce and harmless, and did not again become multiplied till after the rains had ceased and the third brood had developed; by which time the crop was sufficiently matured to be out of danger. Very much the same conditions occurred all over the upper Mississippi Valley country, and as there was an increased acreage planted, the crop throughout this whole section was larger and prices lower than they have been for many years. Indeed in some parts of Michigan, Ohio and Indiana, it has been difficult to dispose of potatoes at even 25c. per bushel.

IN THE ATLANTIC STATES

the insect attracted much more attention. From almost all parts of New York, New Jersey, Pennsylvania and Virginia, accounts came of the excessive numbers in which the pest made its appearance in the months of May and June. Local papers throughout the States mentioned, published records of the insect's injury and laid the experience that had been gained in the States to the West before their readers; while even large city dailies, like the *World* and *Herald* of New York, devoted column after column to Doryphora's consideration.

Judging from the mass of accounts, the first brood was very generally neglected by those who had not before had experience with the insect, and not till the more numerous second brood appeared did the farmers awake to the importance of action, and, as far as possible, concerted action. Much injury was consequently done.

Later in the season the beetle at times swarmed in and about the large cities, and was commonly seen flying in the streets of Philadelphia and New York, as in past years it had been seen in those of St. Louis. Mr. J. J. Dean of New York, after referring to its frequency in the streets of Brooklyn, gives me the following interesting account of its occurrence on Coney Island.

On the 14th of September I picked up the enclosed specimen at Coney Island. The beach for miles was covered with them—the hummocks and sand-hills which comprise the greater part of the island were literally alive with them. In the towns of Flatbush and Gravesend, both situated in King's Co. — the latter town including Coney Island within its boundaries—the ravages of this insect have been very serious. The Egg-plant seems to have afforded him his favorite article of diet. I am however puzzled by the fact that so many millions of them desert the fertile fields of Flatbush and Gravesend and steer for the barren acres of Coney Island, on which the principal vegetation is a coarse sea grass which they do not seem to touch. They appear to have an irresistible tendency to travel East and are only stopped by the waves of the Atlantic Ocean.

In the Fall the insect reached up into Vermont and extended to within a few miles of Boston,* but has not yet occurred in Maine.

ITS SCIENTIFIC NAME.

In further support of the views expressed last year on this subject, I will add that an examination which I was permitted to make last summer of the admirable and extensive collection of Chrysomelidæ belonging to H. W. Bates, of London, shows that the tibial groove on which Stal founds his new genus *Leptinotarsa*, to which our potato beetle is referred and under which it is published in Gemminger and Harold's Catalogue, is really of no generic value. Several genuine Doryphoræ with the sternal spine fully developed have it in varying degree, and in *concatenata*, Fabr. it is even more conspicuous than in 10-*lineata*. I fully agree with Dr. LeConte, that if any character has value in separating 10-*lineata*, it is the form of the palpi which ally it more to *Doryphora* than to *Chrysomela*, and make of it, with a few others, a natural group in that genus, distinguished by peculiar coloration and want of development of the sternal spine.

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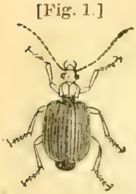
* Mr. Geo H. Perkins, Prof. of Geology and Zoology in the University of Vermont writes: "It may interest you to know that the Doryphora 10-lineata, the genuine animal, was found in the western part of this State last August. I think it did not appear much before, as I was on the look out for it." Dr. Packard (*Scientific Farmer*, Feb. 1876) records its appearance at several places in Massachusetts.

NATURAL ENEMIES.

The different natural enemies that have been enumerated in these reports were often found efficiently working to aid man in destroying the pests, and two additional ones have been reported. Mr. P. R. Uhler found the Black-bellied Lebia (*Lebia atriventris* Say, a species of the same color and general appearance, but only half as large as *L. grandis*, Fig. 1) destroying it around Baltimore; while the editor of the *American Agriculturist* in the January (1876) number of that excellent journal, gives good evidence (p. 18) that the common crow devours the beetles, and even digs up the ground to get at them after they have entered it to hibernate.

[Fig. 1.]



LEBIA GRANDIS.

REMEDIES.

The prevailing remedy has been the Paris Green mixture recommended in the Fifth Report. Mr. Trask Lee, Trumble Co., Ky. (*Country Gentleman*, April 29, 1875) shows that with flour that cost him $6.50 per barrel (the poorer and cheaper quality answering as well) he protected 8½ acres at a cost of $17.42, including labor. He prefers flour and Paris Green to everything else; and so does Mr. Elias Mott (*ibid.* April 8, 1875) and many others for the reasons which I have already given. "T. of Iowa," in which signature I recognize an old friend and intelligent observer, gives the following experience in the *Prairie Farmer* for July 3, 1875:

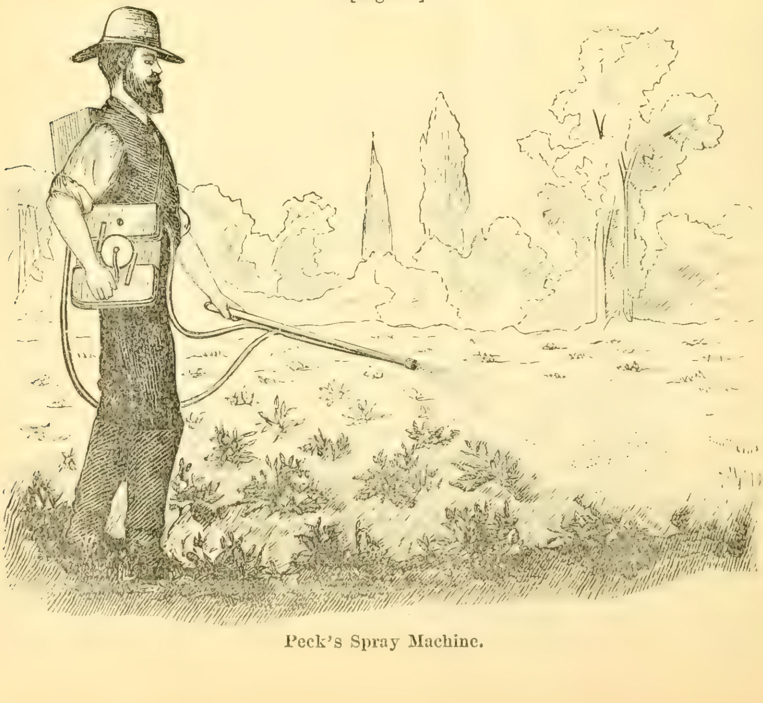
> I have had quite as good success in using the ingredients from which the green is made, as from the finished article, bought in paint and drug shops at 50 cents a pound, especially when the local demand is so great that it cannot be bought at all. The following directions for making it are taken from Brande's Chemistry: Dissolve two pounds of sulphate of copper, blue vitriol, (costing 20 cents per lb., or 40 cents) in a gallon of hot water, keeping it in a stone jar. Dissolve in another large jar, one pound of white arsenic, (costing 10 cents), and two pounds of saleratus or pear ash (cost 20 cents) in forty-four pounds of hot water, stirring well, till thoroughly dissolved. These articles, costing 75 cents, will make about five pounds of Paris green, costing $2 50. I usually keep them in solution and mix in the proper proportions, one part of the first to five of the latter, as they are needed. The green immediately begins to precipitate in a fine powder, and is much more convenient for use, in solution, than the dry article sold in the shops.

Among the novel methods that have been employed in defence against Doryphora, two are more particularly worthy of mention as being reasonable and preventive, and as having been employed with success. The first is to slice potatoes, dust the pieces with Paris Green and drop them about a field early in the season when the beetles come from their winter quarters. They feed upon the slices and of course die. The method can only be safely practiced where no domestic animals can get at the baits. The second is that first employed by Mr. James Rivers of Cass County, Mich., viz., a mixture of chicken manure and ashes, applied to each hill of potatoes just as the plants are coming through the ground—the object being to check the cracking and raising of the soil, and thus prevent the beetles from hiding around the young plants at night or during cold weather. The application appears in addition to keep the beetles off, at the same time that it invigorates the plant.

Col. Fred. Hecker, of Summerfield, Ills., writes me that he had the past summer a patch of potatoes covered with straw, which had entire immunity from the insects' attacks; but it is doubtful whether under the same treatment such immunity could always be relied upon.

Of machines not previously referred to, Mr. S. S. Rathvon of Lancaster, Pa., speaks very favorably, from experience, of one patented by Mr. Anthony Iske of that town. It is a machine simple in construction, but is quite effective in sweeping the bugs from potato and tobacco plants into receptacles provided for that purpose. It is composed of two pieces of tin gutter pipe, about two feet long, which hang near the ground, one on each side of the row of plants, while above them is suspended a broom. The revolution of the wheels on which the machine is propelled causes the broom to vibrate from side to side, knocking the bugs off the plants against wooden shields, which are placed behind the gutters into which the insects fall. The gutters are said to be adjustable and to accommodate themselves to the

[Fig. 2.]



Peck's Spray Machine.

shape of the ground and the size of the plants. From plans and descriptions which have been submitted to me I am not very favorably impressed with the invention. The machine looks cumbersome; and the work it proposes to do can, I think, be done in a more simple way.

An excellent spray machine carried on the back after the style of the Gray Sprinkler described in my last report, has been invented by Mr. W. P. Peck, of West Grove, Pa., who kindly sent me one of the machines for trial with the following explanatory remarks: "Like many an other inventor I have found something to do since I thought my invention complete. To apply a liquid to trees there must be force to raise it above the tank. My plan for doing this is to connect the blower with the tank by means of a rubber pipe passing over the left shoulder which creates a pressure of air in the tank. By this means liquid can be raised two or three feet above the head and by the aid of a step-ladder six or eight feet in height we are able to make application to trees 14 or 15 feet from the ground. I have been trying and hoping to discover some plan that would enable me to do without the step-ladder and have delayed sending out any Atomizers until I could do so, but have given it up for the present, and the company have begun to fill orders."

This atomizer, can of course be used to distribute other liquids than Paris Green water, and to protect other plants than potatoes; but for use in the potato field it answers an admirable purpose. The tank holds three gallons and there is a simple device at the bottom which by the motion of walking keeps the liquid in agitation and prevents the mineral from settling. The liquid issues in so fine a spray that it is scarcely perceptible.

FURTHER EXPERIENCE WITH PARIS GREEN.

Last year I discussed the value of this mineral as an insecticide, especially in reference to the insect under consideration. So far as past experience, and the facts at that time known, permitted, its influence on the plant, on the soil, and on man either indirectly through the soil or through the plant, was considered; the conclusion arrived at being that, used with ordinary caution and judgment, it was a valuable and safe remedy. This had long been the conclusion of practical men in the Mississippi Valley who had used it extensively; but the question was opened again by a paper read by Dr. J. L. LeConte of Philadelphia, before the National Academy of Science, which paper, from the theoretical side, strongly condemned the use of the poison for the purposes mentioned, and which naturally attracted considerable attention and was harped upon by the manufacturers of "potato bug machines," or their glib agents. The National Academy, after the reading of Dr. LeConte's paper, appointed a committee to "investigate and report upon the subject of the use of poisons applied to vegetables or otherwise for the destruction of deleterious insects and other animals," etc.; but that committee has, I believe, made no report yet. Prof. R. C. Kedzie, of the Michigan Agricultural College did, however, carry on a series of interesting experiments last summer, and while visiting the college in August I had the pleasure of witnessing and making notes of the Professor's operations. As he has since given these results to the American Public Health Association, and published an abstract of them in the *Detroit Free Press*, I take the liberty of giving them wider circulation.

First, as to the use of the mineral for the Doryphora. Does Paris Green poison the tuber? Tubers taken from vines that had been repeatedly dosed with the ordinary mixture—as much Paris Green, in fact, as they would bear—gave no trace of arsenic. Regarding the idea, which has been suggested, that the use of the poison rendered the tubers watery and waxy, the conclusion is that such condition is brought about by the stunted growth and destruction of the vines caused by the insect, which thereby prevents maturity of the tuber. Does Paris Green poison the land? This is meant, of course, in the sense of rendering the land unfit for the growth of crops; and Prof. Kedzie justly considers not only its immediate, but its remote effect. Theoretically, one would naturally infer that Paris Green is converted into an insoluble precipitate or salt with the hydrated oxide of iron which exists in most soils; but not resting the matter on theoretical or abstract reasoning, Prof. Kedzie made careful tests and experiments. He passed a solution of arsenious trioxide through common garden soil, and filtered Paris Green in a solution of hydrochloric acid through dry earth. In neither case could any poison be detected in the filtrate by the severest tests. Soil taken from a field of wheat that had been sown with Paris Green at the rate of five pounds to the acre showed no trace of the poison when submitted to any or all of the tests which the soil would get by natural solvents in the field, but distinctly showed the arsenic when treated with dilute sulphuric acid. The Paris Green was sown on the ground early in Spring, and was thick enough to give a very distinct green tint to the surface. The grain and the straw were submitted to careful chemical examination, as were also cabbages grown in soil that had the year before been in potatoes and received a heavy sprinkling of Green. No trace of the poison was found in either, and it was observed that the chipmunks ate large quantities of the grain without injury. The more practical conclusions from Prof. Kedzie's experiments may be thus summed up:

1. Paris Green that has been four months in the soil no longer remains as such, but has passed into some less soluble state, and is unaffected by the ordinary solvents of the soil. 2. When applied in small quantities, such as alone are necessary in destroying injurious insects, it does not affect the health of the plant. 3. The power of the soil to hold arsenious acids and arsenites in insoluble form will prevent water from becoming poisoned, unless the Green is used in excess of any requirement as an insecticide.

These experiments of Prof. Kedzie's accord, so far as they refer to the influence of Paris Green on man through the plants, with others by Prof. McMurtrie of the Department of Agriculture, which showed that even where the Green was applied to the soil in such quantities as to cause the wilting or death of the plants, the most rigorous chemical analysis could detect no trace of arsenic in the composition of the plants themselves. They also fully bear out the opinions which I have always held, and justify the advice which I have given.

Before leaving this subject of remedies for the Colorado potato-beetle, it may be well to say a few words about two other compounds that have been strongly recommended and advertised as such. The most notable of these is that advertised as "Potato Pest Poison," by the Lodi Chemical Works of Lodi, N. J. It is put up in pound packages, which are sold at $1 each, with directions to dissolve four ounces in two quarts of hot water, then pour into a barrel containing thirty gallons of cold water, and use on the vines in as fine a spray as possible. Analysis shows it to be composed of one part pure salt and one part of arsenic (arsenate of copper), and it has the general color and appearance of common salt. Early in September, during quite hot and dry weather, I had this poison tested in a field of late potatoes belonging to Mr. W. Hinterthur of Laclede, Mo., the field having been badly infested during the Summer, but about half the vines having been saved by pretty constant hand-picking. These were at the time fairly covered with the insect in the egg, larva, and beetle states. Five rows were treated with the poison, both according to directions and by finely sprinkling the dry powder over the vines. As soon as the powder touched the larvæ, they writhed and became restless, as with pain, the powder dissolved and formed a translucent coating upon them, and in about three hours they began to die. The beetles were not so easily affected, though they too were in time killed by it. Used as directed, it destroys, but hardly as efficiently as the ordinary Paris Green mixture. A pound of Paris Green, costing much less than a pound of the Lodi poison, will go nearly as far in protecting a field of potatoes, and I cannot see any advantage to the farmer from the employment of a patent poisonous compound of the nature of which he is ignorant, when a cheaper one is at hand. The color of the Lodi poison is also very objectionable, as there is much more danger in the use of poisons when their color renders them undistiguishable from ordinary salt. The other powder is one prepared by a gentleman in Philadelphia, and strongly recommended as a "potato-bug remedy." It was given to me by Dr. J. L. LeConte for trial. It is a dull, yellowish powder, which when analyzed proves to be crude "flowers of sulphur," containing 95 per cent. of sulphur and 5 per cent. of impurity and coloring matter, such as yellow ocher, sand, etc. A thorough trial on the potato patch above mentioned showed it to be entirely worthless. In conclusion, the fact that Paris Green cautiously handled and judiciously used, is an excellent and cheap antidote to the ravages of the Colorado potato-beetle, cannot be too strongly urged. That it is useful against some other insect pests is also true; but it is sometimes recommended for suctorial insects, which it will not affect as it does those which masticate, and its too general use should be opposed. In an emergency it may be used against the Canker Worm. Yet I cannot recommend it in such a case where other available preventive means are at hand—means which are as simple as they are dangerless.

A method of using it during the year in suspension that gave satisfaction was by pouring a gallon of molasses and a pound of Green into a barrel of water, the molasses having the tendency to make the Green stick better to the foliage.

THE INSECT'S NATIVE HOME.

As in the case of all insects that spread or are introduced from one section of country to another, it is interesting to know the original home or range of the Colorado Potato-beetle, so far as such can be learned, though the question has no especial practical bearing. Following Walsh, I have always believed that this species, which has gradually spread to the Atlantic, originally came from the mountain regions of Colorado, and the reasons given are sufficiently convincing to have been very generally accepted as valid. Nevertheless Prof. Cyrus Thomas questions the soundness of the theory in the following language, which I quote because Mr. Thomas's views are entitled to careful consideration:

> The first we hear of its attacking the potato, so far as I can ascertain, is in 1859, at which time it was in Nebraska, about 100 miles west of Omaha; the next we hear of it is in Iowa, in 1861, from which point its progress has been carefully noted. Now, it is not contended by any one that it travels except from potato patch to potato patch. That it manages in some way to get over intervening spaces of a few miles, is admitted, but never over spaces which require the production of intervening broods. Previous to

1859, as is well known, there was an intervening space between the border settlements of Nebraska and the eastern base of the mountains of two or three hundred miles in which there were no potato patches. How are we to account for its bridging this space; what induced it to take up its line of march across this barren region in which there were no settlements? Is it not much more reasonable to suppose the plains themselves formed its native habitat, and that as soon as the pioneer settlements reached this region and the potato was introduced, it commenced its attack upon it, and then began its march eastward along the cultivated area?—*Western Rural, Dec. 4, 1875.*

The weak points in the above reasoning are that it implies, first, that the insect travels only from potato patch to potato patch, and that there must have been potatoes at every few miles between the point west of Nebraska where the beetle was first noticed on cultivated plants and the mountains; second, that no cultivated potatoes were grown on said plains. In truth, however, potatoes were undoubtedly grown around Fort Keaney and other forts and settlements prior to that time, and the beetle may travel by the spreading of other wild species of *Solanum*, and by being carried along water courses or on vehicles. One point that may be urged in favor of the supposition that the insect was indigenous to the plains that reach far eastward into Kansas and Nebraska, is that it was unobserved in potato fields by certain parties in parts of Colorado after it had reached as far as Iowa. The point is, however, weakened by the fact that it was found in great abundance in Colorado by Drs. Velie and Parry in 1864. Another point that may be made is that it is difficult to imagine that an insect with such a natural predilection for *Solanum tuberosum* could have passed from settlement to settlement across the plains without its depredations being noticed and recorded. But this last point may also be turned against Prof. Thomas's supposition, since it is also just as difficult to imagine that the potato patches that have been grown in restricted localities on the plains should have remained untouched, if the insect had always existed on those plains. Moreover since potatoes were cultivated on the eastern borders of the plains in Nebraska and Kansas long prior to 1859, there can be no good explanation why the insect did not sooner commence its eastward march, except on the theory of a natural barrier in the shape of the more barren plains, which had up to that time prevented its advance from more western confines.

Mr. Thomas, in support of his views, supposes that the sand bur (*Solanum rostratum*) originally occurred over the plains in question, citing as proof Gray's "Wild on the Plains West of the Mississippi," and the localities given by Porter and Coulter in their "Flora of Colorado." Dr. Gray's language is altogether too general to help much in the argument, and refers to the range of the plant ten years after the beetle had appeared in Nebraska. Porter and Coulter's localities are all in Colorado, and their "Plains of the Platte" doubtless refers to the south fork of that river. At all events, nothing is more certain then that the original home of the plant was the more fertile portions of the mountain region, and that, like the beetle which it nourished, it has been for many years extending its range eastward through man's agency in one way and another, and is now rapidly extending across Missouri, where but a few years back it was entirely unknown. Mr. Carruth, of Topeka, says that prior to 1864, it was unknown in Kansas, and Mr. C. W. Johnson, of Atchison, writes me that the coming of Doryphora and of the weed in question were cotemporaneous in that section; that the northern dispersion of the plant from the South-west, through the Texas cattle traffic, afforded the means by which the beetle passed the great stretches of prairie lying east of its native haunts.

Bearing in mind that as early as 1824 Say reported the beetle sufficiently common on the upper Missouri, and that it flourishes most in the more northern of the States, I think we may justly conclude that the native home of the species is the more fertile country east of the mountains, extending from the Black Hills to Mexico, where it becomes scarce, and is represented by *Doryphora undecemlineata* and *D. melanothorax*.* Putting all the facts together, we may also conclude that it crossed the great plains through man's agency. That it first reached the more fertile cultivated region to the east, in Nebraska, finds explanation, perhaps, in the fact that travel was greatest along that parallel, and that the insect's natural range extended further eastward in those more northern parts, just as the mountain region does in Wyoming and Dakota.

On the whole, Walsh's theory is doubtless at fault, and needs modification in so far as it implies that the insect necessarily came from Colorado, but I can but think that Doryphora came from the Rocky Mountain region, and that civilization, in the way of traffic, travel, and settlement on the plains, was the means of bringing it, and that if we put not a too strict construction on his language, Walsh's views are in the main correct.

THE POISONOUS QUALITIES OF THE INSECT.

Some interesting experiments, to test the poisonous qualities of these insects, were made during the year by Messrs. A. R. Grote and

* Mr. W. S. M. d'Urban mentions in the February (1876) number of the *Entomologist's Monthly Magazine* (London) finding a specimen of the beetle in a case of Coleoptera sent from New Grenada as long ago as 1845. I do not believe 10-*lineata* occurs there, and am strongly of the opinion that some one of the similarly marked and closely allied species has been mistaken for it by Mr. d'Urban. The 11-*lineata*, for instance, which Stal reports from Mexico, Costa Rica, Bagota, and Bolivia might easily be so mistaken, and was for some time actually so mistaken by the members of the Belgian Entomological Society in the discussions had in that body about a year ago as to the possibility of the importation of our Colorado Potato-beetle.

Adolph Kayser, and reported in a paper entitled "Are Potato Bugs poisonous?" read before the American Association for the Advancement of Science at its meeting in Detroit. The following extracts give the substance of the paper:

To investigate the matter, a quantity of the bugs collected from fields near Buffalo, where no arsenic had been used, was submitted to distillation with salt water, so as to allow of an increased temperature. Under this process, about four ounces of liquid were procured from one quart measure of the insects. This liquid was perfectly clear, and emitted a highly offensive smell; it proved of alkaline reaction on account of the presence of a certain quantity of free ammonia and carbonate of ammonia.

Again, an equal quantity of the bugs was used to prepare a tincture made as follows:—Absolute and chemically pure alcohol was condensed upon the live bugs; after a digestion of twenty-four hours the alcohol was evaporated at a gentle heat. The tincture so obtained had a decidedly acid reaction, was brown in color, and was not disagreeable in smell.

To ascertain the effect on the animal system of the liquid and the tincture above described, a number of frogs were procured for the experiment. About one half cubic centimeter of the liquid and the tincture each was introduced separately into the stomach. Neither the liquid nor the tincture produced any apparent effects. The vivacity of the frogs so treated continued unimpaired, notwithstanding the complete retention of the doses. Again two fresh frogs were submitted to a hypodermic injection of the liquid and the tincture, in the hind legs, by means of an ordinary hypodermic syringe. The injection of the distilled liquid was unattended by injurious results. A slight disinclination, at first, to use the hind limbs was shown also in the case of another frog, which was treated hypodermically with pure water to check the results obtained.

The injection of the tincture, however, proved fatal to the subject. A few moments after the injection the leg operated upon seemed to become paralyzed, and the heart stopped beating within thirty minutes afterwards, by which time the other two hypodermically treated seemed to have completely overcome the effects of the operation.

The tincture though highly concentrated, contained but a small quantity of animal acids. * * * The acids being found to be present in such small quantity, the conclusion is unavoidable, in the light of the present experiments, that the bugs are *not* poisonous.

The experimenters conclude that the reported cases of poisoning result rather from the arsenic used in destroying the insects, or from carbonous oxide produced by incomplete combustion when large amounts of the beetles are thrown into a fire. It is to be hoped that the experiments will be continued, 1st, because they by no means cover the whole ground; 2nd, because, so far, they admit of the opposite conclusion to which the experimenters arrived. Until we have learned what the active principle is which produces the physiological effect that has been well attested, and the precise conditions under which it acts, the experience recorded in my last report will go for more than such experiments. The active principle, as there stated, is most probably volatile, and the processes described in the above experiments very probably had the effect to liberate the poison. Boiling is well known to destroy many organic poisons in this manner or by decomposition, and the green tuber, the fruit and haulm of the common potato lose their poisonous qualities by being so treated. In obtaining tinctures, whether by percolation of the powdered material, or as described in the experiments, the poisonous principle may, further, not be extracted: it may be coagulated by, or insoluble in the alcohol, and it is quite essential that we know the nature of the vessel employed.

In conclusion, the physiological effects of a poison may differ vastly as between cold and warm blooded animals; the tincture is admitted to have contained an acid (which may be the poisonous principle) and to have killed a frog; and the possible injurious effect of the fumes from burning the insects granted. I therefore find no reason to change the views expressed a year ago, and it is worthy of note that Prof. A. J. Cook of the Michigan Agricultural College, from experiments somewhat similar to those of Messrs. Grote and Kayser, has arrived at opposite conclusions to those which these gentlemen came to.

CANKER WORMS.

(Ord. LEPIDOPTERA; Fam. PHALÆNIDÆ.*)

In my seventh Report I illustrated and explained the differences in habit and structure between the Spring and Fall Canker-worms which had been for so many years confounded. Further investigations during 1875 have enabled me to still more fully complete the comparisons there instituted, and have shown that the structural differences are greater than I had at first supposed. These differences led me to separate the insects generically, in a paper read last Fall before the St. Louis Academy of Science. The volume of Transactions in which this paper is published will not be given to the public for many months to come, and in order to lay the subject before the reader in succinct form, and at the risk of repeating much that has appeared in my previous reports, I here reproduce the paper *in extenso*, with only such alterations as are necessitated by the proper references to the figures.

REMARKS ON CANKER-WORMS AND DESCRIPTION OF A NEW GENUS OF PHALÆNIDÆ.

[Read before the St. Louis Academy of Science, Oct. 14, 1875.]

From the time when Wm. Dandridge Peck published (in 1795) his essay on the Canker-worm, which received a prize from the Massachusetts Society for Promoting Agriculture, up to the year 1873, all writers on the subject spoke of THE Canker-worm under the impression that there was but one species. Nevertheless two very distinct species have been confounded under this name. The first intimation we have of there being two species is where Harris—after describing at length, as THE Canker-worm Moth, not the species first called the Canker-worm by Peck, but the larger species (*pometaria*) here treated of—uses the following language: "Specimens of a rather

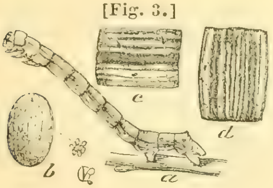
* Hybernidæ of Guenée.

smaller size are sometimes found, resembling the figure and description given by Prof. Peck in which the whitish bands and spots are wanting, and there are three interrupted, dusky lines across the fore-wings, with an oblique, blackish dash near the tip. Perhaps they constitute a different species from that of *the true Canker-worm moth.* Should this be the case, *the latter* may be called *Anisopteryx pometaria*."* The portions of this passage which I have italicized are well calculated to mislead, for the term "true Canker-worm Moth," should only apply, in justice, to that described as such by Prof. Peck, and not, as Harris here applies it, to the other species. Indeed, most subsequent writers, including Fitch, Packard, Mann, and myself,† were misled by the language, and took it for granted that the name *pometaria* was proposed for the smaller form—a mistake first clearly pointed out by Mr. H. K. Morrison, of Cambridge.‡

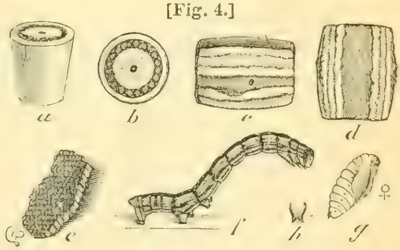
So long as the male moths only were carelessly compared, there was always a question as to whether the differences were varietal or specific—1st, because the general resemblance is strong; 2d, because each species varies considerably both in size and ornamentation; 3d, because the wing-scales, especially of one species, easily rub off, and perfect specimens, captured at large, are uncommon. More careful comparisons made in 1873 by Mr. Mann (*loc. cit.*) between both sexes, established the specific differences of the two; and further comparisons, by myself,§ of the preparatory states, showed these differences to be still more remarkable than had been supposed. During the present year I have been able to make still more careful comparisons, which show the two insects to be so very distinct that they must be separated generically. These differences are set forth in the following comparative columns. They show that *pometaria* alone can be retained in the genus *Anisopteryx*, and for *vernata* I have, therefore, erected a new genus, *Paleacrita*.

PALEACRITA VERNATA.	ANISOPTERYX POMETARIA.
	Egg.
Elliptic-ovoid, the shell of delicate texture and quite yielding; generally appearing shagreened or irregularly impressed; nacreous, and laid in irregular masses in secreted places. (Fig. 3, *b.*)	Squarely docked at top, with a central puncture and a brown circle near the border; of firm texture, and laid side by side in regular rows and compact batches, and generally exposed. (Fig. 4. *a*, *b*, *c.*)

[Fig. 3.]



[Fig. 4.]



	Larva.
No. prolegs on joint 8. (Fig. 3, *a.*)	With a pair of short but distinct prolegs on joint 8. (Fig. 4, *f.*)

* *Insects Injurious to Vegetation*, 3rd ed. p. 462.

† *Vide* Fitch, Rep. III, § 38; Packard's *Guide*, 3rd ed. p. 324; Mann. Proc. Bost. Soc. Nat. Hist., xv. p. 382, Riley; Mo. Rep. vi. p. 29.

‡ Proc. Bost. Soc. Nat. Hist. vol. xvi. p. 204.

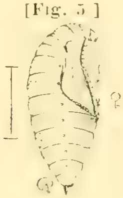
§ 7th Mo. Ent. Rep., pp. 80-88.

PALEACRITA VERNATA.	ANISOPTERYX POMETARIA.
Head distinctly mottled and spotted, the top pale, and two pale transverse lines in front.	Head very indistinctly spotted, and dark on top.
Body with eight superior, narrow, pale, longitudinal lines barely discernible, the two lowermost much farther apart than the others.	Only six superior, broad, and very distinct pale lines, those each side equidistant.
Dorsum pale, with median black spots; subdorsal region dark; stigmatal region quite pale.	Dorsum dark, without ornament; subdorsal region pale; stigmatal region dark.
Pilliferous spots quite visible and large on joint 11, where the pale lines generally enlarge into white spots immediately in front of them.	Pilliferous spots subobsolete.
When newly hatched *dark* olive-green or brown, with black shiny head and cervical shield.	When newly hatched *pale* olive-green, with very pale head and cervical shield.

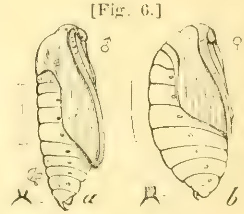
Chrysalis.

Formed in a simple earthen cell, the earth compressed, and lined with very few silken threads so as to form a fragile cocoon, which easily breaks to pieces.	Formed in a perfect cocoon of fine, densely spun silk of a buff color, interwoven on the outside with particles of earth; never breaking open except by force or purpose.

[Fig. 5.]



[Fig. 6.]



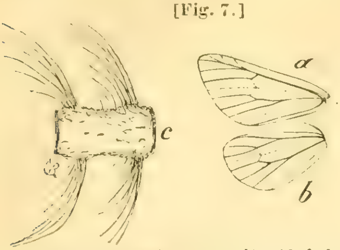
MALE—Sparsely and shallowly pitted. Pale grayish-brown, with a greenish tint on the wing-sheaths, which extend to the posterior edge of the 5th abdominal joint; abdomen with the spine at tip gneerally simple, and only occasionally slightly bifurcate.	MALE—Not pitted. Darker brown than *vernata;* the wing sheaths, as in *vernata*, reaching to the 6th abdominal joint; the anus more blunt and with the spine more dorsal, decurved, and always bifurcate, the prongs spreading and often long and fine. (Fig. 6, *a*.)
FEMALE—With wing-sheaths, but compared with those of the male, thinner and extending only to the posterior edge of the 4th abdominal joint: much more robust and more arched dorsally, with the mesothoracic joint shorter, and much reduced in size. Pitted like the male. (Fig. 5.)	FEMALE—Differs from the male in the same way as *vernata*, but is relatively stouter and more arched dorsally: a broad, dusky, dorsal stripe often visible toward the time of issuing—all the more remarkable that there is no such stripe on the imago, whereas in *vernata*, where the imago has such a stripe, it is not indicated in the chrysalis. (Fig. 6, *b*.)

Imago.

PALEACRITA VERNATA.

MALE—*Palpi* very short, but distinctly 2-jointed.

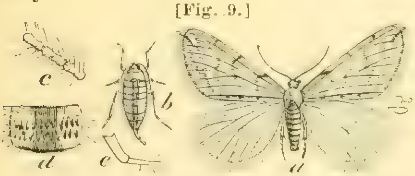
[Fig. 7.]



Antennæ with not quite 40 joints, the longest more than twice as long as wide, each with *two pairs* of hair fascicles, springing from very slight, lateral elevations, the longest hair about thrice the diameter of joint. Looking from above, with ordinary lens-power, these hairs give the appearance of fine, ciliate pectinations. (Fig. 7, *c.*)

Abdomen with the first seven joints bearing each two transverse dorsal rows of stiff, reddish spines, pointing posteriorily.

[Fig. 9.]



Wings delicate, silky, semi-transparent, transversely striate, the scales short and very loosely attached.

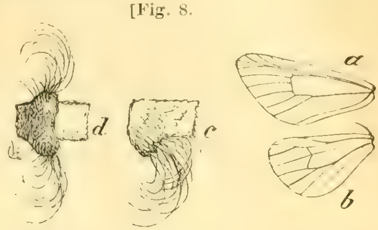
Front-wings with costal and sub-costal veins well united, with the discal cross-vein partially open, and but *two* short costal branches, the superior veins straight.* (Fig. 7, *a.*)

Upper surface brownish-gray.

ANISOPTERYX POMETARIA.

MALE—*Palpi* rudimentary with joints indistinguishable.

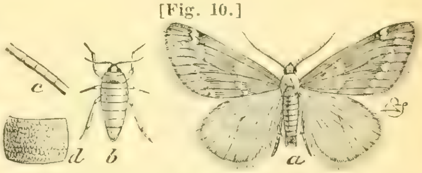
[Fig. 8.



Antennæ with over 50 joints, the longest not twice as long as wide, each with *one pair* of fascicles of slightly curled hairs, the longest about thrice as long as the diameter of the joint, and all springing from a prominent, dark hump which occupies the basal half of the joint beneath, and gives a somewhat serrate appearance from the side. The same appearance of ciliate pectinations looking from above. (Fig. 8, *c*, *d.*)

Abdomen without spines and often with a moderate anal brush.

[Fig. 10.]



Wings less transparent, more glossy, not striate, the scales on an average longer and more firmly attached.

Front-wings with costal and sub-costal less closely united, with the discal cross-vein well closed, and with *three* costal branches. All the veins 7–11 are more distinctly separated and the superiors more curved, veins 9 and 10 forming an open areolet near the disc: the apex more produced. (Fig. 8, *a.*)

Upper surface also brownish-gray, but somewhat darker, with a purplish reflection.

*A microscopic examination shows the venation in *vernata* to be on the same plan as that in *pometaria*. The difference is that in *vernata* the costal vein is feeble and generally obsolete at its termination, and all the veins 7–12 are more closely united with the costal than in *pometaria*.

PALEACRITA VERNATA.	ANISOPTERYX POMETARIA.
Crossed by three jagged, dark lines, sometimes obsolete except on the submedian and median veins, and on the costa where they are always distinct and divide the wing into four subequal parts. No white costal spot. (Fig. 9, *a.*)	Crossed by two less jagged, whitish bands, the outermost suddenly bending inward near costa, where it forms a pale, quadrate spot, relieved by a darker shading of the wing around it: the bands sometimes so obsolete as to leave only this pale spot; but more often relieved on the sides toward each other by a dark shade, most persistent on the veins. (Fig. 10, *a*)
A pale, jagged, subterminal band, corresponding in some degree to the outermost band in *pometaria*, but running out to apex, where it is always sharply relieved posteriorly by a dark mark, and often the whole length by dusky shadings.	No such band.
Hind-wings with the costal vein bifurcating at, or but little beyond, the discal, and with the independent or vein 5 faint. (Fig. 7, *b.*)	*Hind-wings* with the costal vein bifurcating considerably beyond the discal, which is strongly elbowed; vein 5 quite strong. (Fig. 8, *b.*)
Color pale-ash or very light gray, with a dusky discal dot.	Grayish-brown, with a faint blackish discal dot.
No white band, and rarely any marginal dots.	In most specimens a curved white band runs across the wing, and the veins inside this band and on hind border are generally dotted.
Under surface with a more or less distinct dusky spot on each wing, the front wing having in addition a dusky line along median vein and spot on costa toward apex. No pale bands.	*Under surface* with a dusky discal spot on each wing, and with the outer pale band on upper surface of front-wings as well as that of the hind-wings showing distinctly, the former relieved by a dusky spot inside at costa.
FEMALE—*Antennæ* generally with but few more than 30 joints, the longest about thrice as long as wide, faintly constricted in middle, and pubescent. (Fig. 9, *c.*)	FEMALE—*Antennæ* with over 50 joints, the longest hardly longer than broad; uniform in diameter; without pubescence. (Fig. 10, *c.*)
Body and legs pubescent, clothed with whitish and brown, or black, dentate scales or hairs; general coloration not uniform. Crest of prothorax and mesothorax black. A black stripe along the middle of the back of the abdomen, often interrupted on the second to seventh joints, with a whitish patch each side of its front end. (Fig. 9, *b. d.*)	*Body and legs* smooth, clothed with glistening brown and white truncate scales intermixed, giving it an appearance of uniform, shiny, dark ash-gray: somewhat paler beneath. (Fig. 10, *b. d.*)
Abdomen tapering rather acutely behind, and with an exsertile, two-jointed, conspicuous ovipositor. (Fig. 9, *e.*)	*Abdomen* tapering rather bluntly behind, without exsertile ovipositor.

PALEACRITA VERNATA.	ANISOPTERYX POMETARIA.
Two rows of spines on back of the first seven joints more prominent than in the male, and often giving the dorsum a reddish aspect. (Fig. 9, *d.*)	No spines on abdomen.
Of a rather smaller size than *pometaria*, the wings of the male expanding from 0.86–1.30 inches, and the female measuring 0.20–0.35 inch in length.	The wings of the male expand from 1.05–1.35 inches; and the female measures 0.25–0.40 inch.

From the above detailed descriptions of the two species it is evident that, as already remarked, *pometaria* alone can be referred to the genus *Anisopteryx*, and this doubtfully. It agrees with the European species of the genus in the principal pterogostic characters, obsolete tongue, and rudimentary palpi; and is, indeed, the analogue of the well known *æscularia.* Yet in the antennal characters of the male, and especially in the basal hump on each joint, it agrees more nearly with the typical species of the genus *Hybernia* as characterized by Guenée. Again, so far as we now know, it differs from *Anisopteryx* in the additional pair of prolegs in the larva, and in the more distinct areolet in the front-wing. I can find no detailed account of the early states of any of the European species of the genus, though in none of the descriptions of the larva at my command is any mention made of additional prolegs. Mr. Geo. T. Porrit, who particularly describes the larva of *A. æscularia*,* makes no mention of this structural feature, and Guenée particularly says: "Il ne faut pas chercher des charactères pour les *Anisopteryx* dans les premiers états, car les chenilles ne diffèrent ni pour la forme, ni pour les couleurs, ni pour les mœurs, de celles des *Hybernia* du première groupe." Should future observations prove this statement correct, then the characters that belong to *pometaria* may come to be considered of generic value. For the present I deem it best to refer it to *Anisopteryx*, as more careful study will probably show that in the characters of egg, larva, and chrysalis, the European species of the genus agree with it, and that some of the structural features of the adolescent states have been overlooked in Europe, as they so long were in this country.

Paleacrita, nov. gen., approaches much nearer *Hybernia*, from which it is, however, readily distinguished by the double pair of hair fascicles to each ♂ antennal joint; the pubescent hairs that cover the female; the two-jointed, horny, exsertile ovipositor; but, more especially, by the dorsal abdominal spines in both sexes—all characters unmentioned in existing diagnoses of the genus.

One peculiar feature which I noticed in *pometaria* is that the larva molts but twice. Yellowish-white when first hatched, with the black eyelets showing distinctly on the pale head, it soon deepens to pale olive-green, and the three whitish lines each side show soon after birth. It develops very rapidly, often entering the ground within three weeks from hatching. The chrysalis is not formed till about a month afterwards, whereas *vernata* takes on this form two or three days after entering the ground.

The practical lessons to be drawn from the differences here pointed out between these two Canker-worms have been set forth in the report already cited. *Paleacrita vernata* rises from the ground mostly in early Spring, for which reason I have popularly designated it as the Spring Canker-worm. The principal efforts to prevent the female from ascending the tree should, therefore, be made at that season. The cocoon being fragile is easily broken by any disturbance of the land, and, as the chrysalis is more

* *Ent. Month. Mag.* (London) ix. 272.

liable to perish when the cell is broken, fall-plowing of the soil under trees that have been attacked by the worms is to be recommended. The eggs being secreted, for the most part, under loose bark, the scraping of trees in early spring, or any system of keeping them smooth, will act as a preventive of injury. *Anisopteryx pometaria*, which I have called the Fall Canker-worm, rises, for the most part, in the Fall, and should be attacked most persistently at this season. Its cocoon being tougher, and its eggs attached to smooth as well as rough trees, scraping and plowing will effect little in preventing its injuries.

Both species attack fruit and shade trees; but while *vernata* is common and very injurious in the apple orchards of the Western States, *pometaria* is rare there, and most common on the elms of New England.

These two insects, so long confounded, forcibly illustrate the practical importance of minute discriminations in Economic Entomology.

Thus, in addition to the characters pointed out a year ago, we have an important distinction between the two insects, from the practical stand point, in the manner in which the chrysalis state is assumed. The Spring Canker-worm, with its chrysalis formed in a simple earthen cavity, will be very materially affected by late fall plowing of the soil, especially if the soil be of such nature as to crumble easily; for I showed in 1869* that whenever the fragile cocoon is broken open, as it very readily is by disturbance of the soil, at that season the chrysalis has not the power to penetrate it again or to form a second cavity, and either rots, dries out, becomes moldy or, if on the surface, is devoured by birds. For the same reason the rooting of hogs is very beneficial in lessening the work of this species. With the Fall Canker-worm, on the contrary, these measures will avail little, if anything; for the cocoon, composed of a thick layer of yielding silk strengthened by the interweaving of particles of earth cannot be broken open by any such processes, and a dozen plowings would not expose a single chrysalis. Without doubt, we have in these facts a valid explanation of the contradictory experience as to the value of fall plowing or the use of hogs in an orchard as canker-worm checks.

In brief, all the more important measures to be pursued in our warfare against the Spring Canker-worm—such as the use of hindrances to the ascensions of the moths in spring; the removal of all loose bark and keeping the trunk and limbs as smooth and clean as possible; the employment of hogs, and fall plowing—are, in the main, useless as directed against the Fall Canker-worm which must be fought principally by traps or barriers *applied to the tree in the Fall* to prevent the climbing of the moths which mostly issue at that season. Important points like these cannot be too often insisted on, because I find that our horticultural writers yet very generally speak of THE

* 2nd Rep. 102.

Canker-worm as though there were only one species in the country, and give general directions which of course are more or less misleading. I find too that even where the differences pointed out have been recognized, they have not always been properly apprehended; so that in the report of a lecture before the Iowa Agricultural College it is erroneously stated that the Fall Canker-worm hatches in the Fall of the year, whereas, while the moths rise and lay their eggs at that season, these do not hatch any earlier than do those of the Spring species.

Of a number of the Fall species experimented on the past year, I obtained 58 chrysalides from larvæ that had been fed, some of them on Elm, some on Apple, some on Cherry and some on Peach. This last food was evidently relished least and rejected when the other three kinds could be had, but I perceived no preferences for any of the other kinds. A careful examination of the chrysalides in the Autumn showed that out of the 58, only two were males.* I divided the cocoons into two equal lots, placing the one lot in a covered flower pot out-doors, and retaining the other in breeding cages in-doors, so that the first would be submitted to the influence of frost and the other not. From Nov. 8, to Dec. 9, the moths issued almost daily—27 in all, namely, the two males and 25 females. An examination in January, 1876, showed that all the others had perished by rot, induced doubtless by the premature opening of the cocoons in order to examine the chrysalides. Those exposed to frost commenced issuing first, and a larger percentage of moths were obtained than from those kept indoors—which would indicate that a low freezing temperature followed by a thaw assists development, though by no means essential. The two males were placed in a separate, covered pot with five females that issued contemporaneously. Each of these five females was served, and each laid her full complement of eggs, four of them in single batches of 224, 230, 241 and 243 respectively, and the fifth in two batches of 142 and 63 respectively. The first four batches were laid on the smooth pine sticks that supported the muslin cap; the last two on the muslin. In each instance the time occupied in oviposition was between two and three days. None of the unimpregnated females laid regular batches. Most of them laid a few scattered eggs, generally in ones, but also in small groups ranging from 2 to 54.

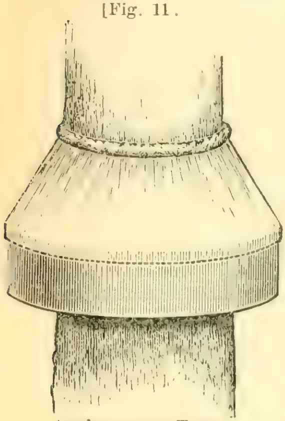
Before concluding these notes I will add to the other contrivances that have been mentioned in previous reports descriptions from the

* Inasmuch as the larvæ were purposely poorly fed—the withholding of food having been carried to the extent that only the number mentioned entered the ground out of some 2,000 that were commenced with; the result is rather damaging to those who believe—if there yet be such—that the male sex can be produced in insects by stunting the larva.

"Illustrated Annual Register of Rural Affairs," published by Luther Tucker & Son of Albany, of two contrivances for protecting trees from this insect, that are unknown in Missouri, and that are very favorably spoken of by that careful horticultural writer, Mr. J. J. Thomas. The first is one successfully used by C. L. Jones of Newark, N. J.

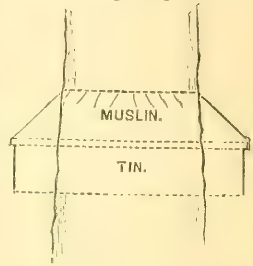
Fig. 11 is a view of the contrivance, which consists essentially of a band or circle of tin, a few inches outside the trunk of the tree, and held there by a circle of muslin, attached to the tin at its edge and drawn with a cord at the top, so as to fit the tree closely, and prevent the insects from getting up without going over the tin, covered with a mixture of castor-oil and kerosene, which as soon as they touch, they drop to the ground. Fig. 12 is a section of the contrivance, and Fig. 13 a section of the union of the tin and muslin, effected by turning over the upper edge of the tin before it is bent to a circle, inserting the edge of the muslin, and hammering them together. The tin may be about three inches wide, and long enough to rest three or four inches off from the trunk, when bent around in the form of a hoop, and secured by rivets or small tacks. After the tin and muslin are attached to the tree, the whole inner or lower surface of the tin is daubed with a mixture of equal parts of kerosene and castor oil. The tin and muslin entirely protect the oil from the sun and the weather, and it will not dry for several days. It will not run down, as the castor-oil thickens it. Of course it needs occasional renewal, with a small brush or feather. This protector is kept on the tree till the moths disappear.

[Fig. 11.]

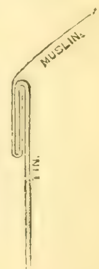


Canker-worm Trap.

[Fig. 12.]



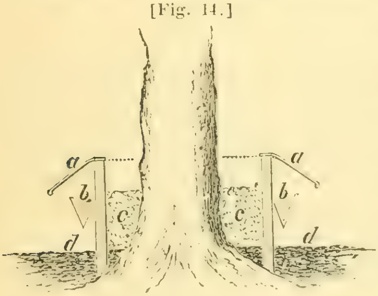
[Fig. 13.]



For those who wish to do work thoroughly while they are about it, and who believe that a little extra time and expense at the start is more than saved in the long run, I do not know that any better contrivance could be recommended. But I would remind the reader that even so perfect an "estopper" as this, may measurably fail, if directed solely against the moths. The worms that hatch below the trap, and which are more difficult to manage, must also be headed off; and I would insist in pursuance of this object, that, in addition to the above directions, the muslin be tied around the tree over a layer of cotton wadding, and that the contrivance be kept on the tree and the tin oiled, at least three weeks after the tree begins to leaf out in the spring. The eggs laid below the trap should, of course, be destroyed as far as they can be, and such destruction in dealing with the Spring species will be facilitated by a bandage of rags below the trap or by anything that will afford the moth shelter for her eggs and that can be easily removed and scalded: where no such lure is used, an application of kerosene will prevent the eggs laid on the tree from hatching. But some are likely to be laid where they escape the closest scrutiny, and while the precautions I have indicated will insure against the ascent of such, whether from the Fall or Spring species; without those precautions some of the newly hatched worms which can pass through a very minute crevice or over the smoothest surface, may get into the tree; and though they may be so few in numbers as to attract no attention they nevertheless perpetuate the species in the orchard. The second contrivance is an old one that has been employed for nearly forty years in Massachusetts, and lately used with satisfaction by Mr. J. G. Barker of Cambridge.

Fig. 14 is a section of the whole contrivance—*a a* being the zinc roof over the oil troughs, *b b*; *d d*, the surface of the earth, *c c*, the tar or lime which is used to fill the box around the tree.

[Fig. 14.]



Canker-worm Trap—Section.

Fig. 15 is a smaller view of the same. The box is square—large enough to leave about four inches of space around the tree; is sunk some four inches in the ground, and rises about ten inches above the surface. The trough is in shape like the letter V, two inches deep, and is made by a tinman before nailing on the box; it is tacked on two inches below the upper edge of the box, and then the roof is placed in position and secured by a single screw into the upper edge of each side or board. It must, of course, be placed in a level position, to hold the oil. This is done by means of a spade used in setting the box in the earth. The box and roof are nearly completed in the tinshop, but the corner of both must be left open till placed around the tree, when the parts are soldered together. The roof is about four and a half inches wide, with the underside turned under about the fourth of an inch, to keep it stiff and in shape. In order to examine the oil, and to see that all is right, it is necessary to loosen one of the screws. The box will vary somewhat in size with the magnitude of the tree; with a trunk six inches in diameter, the box should be about fourteen inches square and fourteen inches high; for a trunk a foot in diameter, it should be about twenty inches square; but a variation of two or three inches would not be of great importance. A few inches of tanbark or lime placed within, is for the purpose of preventing the moths from ascending inside. One pint of crude petroleum (costing 3 cents per tree, at 24 cents per gallon,) is enough for each tree.

[Fig. 15.]

Canker-worm Trap.

With a little care in making a close connection between the v-shaped trough and the box, the above contrivance must work to perfection, as, indeed, Mr. Barker found it to do. Yet on account of the greater labor and expense of making and using it, and of the greater difficulty of examining beneath it, the first described is the preferable of the two. Indeed I should advise the use of Mr. Jones' contrivance, if kept properly oiled, over all forms of troughs whatsoever, for they too often get filled up with the dead bodies of the moths or with leaves, or get bridged with spider web; and where fastened directly around the tree must needs be renewed as the girth of the tree increases.

THE ARMY WORM—*Leucania* unipuncta* Haw.

(Ord. LEPIDOPTERA; Fam. NOCTUIDÆ.†)

The insect which, next to the Rocky Mountain Locust attracted most attention and did most damage in Missouri during the summer of 1875, was the Army Worm. In its destructive power and sudden appearance and disappearance, it may be compared to the dreaded locust of the mountains; but everyone can see how this last comes and goes, upon its wings; whereas the coming and going of the Army Worm are more mysterious and not so well understood.

The species has already been treated of in my second Report; but the experience of six years has added much that is of interest to our general stock of knowledge of so remarkable an animal, and from the evidence adduced a year ago and published in the appendix to the Chinch Bug article, it is manifest that my second Report was very poorly distributed, and is not known to one in a thousand of the farmers of the State. I deem it advisable, therefore, to devote some space in the present Report to the consideration of the Army Worm, and in doing so, I may have occasion to reproduce, in quotation marks, a few passages from the previous article referred to.

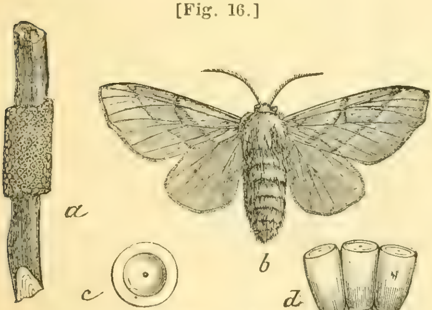
* *Leucanidæ* of Guenée.

† This long known and familiar generic term, applied to a well defined genus, has recently been dropped from our nomenclature—in the writings and in the "List" and "Check List" of N. A. Noctuidæ by Mr. A. R. Grote. It has been replaced by *Heliophila* of Huebner. By this change we pass from light into darkness. I consider that the reasons so long urged by entomologists against the adoption of the classification of the "Tentamen" and "Verzeichniss," and particularly those given by Guenée for not following this last in his admirable work on the Noctuidæ, are good and sound. The Huebnerian classification is essentially unreal, and the generic divisions so inadequately defined that I doubt if any one would attempt to make use of the works in question, were it not for the references to the admirably illustrated works of the same author. The introduction of his generic terms into American Lepidopterology has so upset its nomenclature, without in the least advancing our knowledge, and the grounds for this introduction are so questionable, that those who make these insects a speciality are apt in the future to divide into two factions—the Huebnerites and the ante-Huebnerites; in which event the latter will certainly have strong support from entomologists in general.

THE TERM "ARMY WORM" APPLIED TO VARIOUS INSECTS.

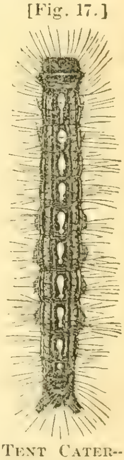
The name "Army Worm" is naturally given to any insect larva that congregates and travels in large numbers. Thus, in parts of Europe some of the owlet moth larvæ and particularly that of *Calocampa exoleta* (Linn.) sometimes go by that name; and on the Pacific coast another larva, which has not, so far as I can learn, been specifically determined, is often reported in the California papers by the name of "Army Worm," as doing great injury to the beet crops. "The Cotton-worm (*Anomis xylina*,* Say), is very generally known by the name of 'the Cotton Army-worm,' in the South. The term as applied to this species is not altogether inappropriate, as the worm frequently appears in immense armies, and when moved by necessity will travel over the ground 'in solid phalanx;' and so long as the word 'Cotton' is attached — its ravages being strictly confined to this plant — there is no danger of its being confounded with the true Army-worm. The term has, furthermore, received the sanction of custom in the Southern States, and of Mr. Glover in his Department Reports." The Army Worm of Jos. B. Lyman, in his "Cotton Culture" (p. 29) is what I have characterized as the Fall Army Worm (Rep. III, 109), an insect closely resembling the true Army Worm in larval appearance and habit, and which I shall presently have occasion to refer to again. The Tent Caterpillar of the Forest (Rep. III, 121) is also frequently dubbed "Army-worm," a fact which is by no means surprising since it often appears in countless numbers and particularly in the more southern States, where it strips the oak forests for hundreds of square miles. In 1872 this species was so numerous around Memphis as to frequently stop the trains going in and out of the city. It stripped orchards, and great lanes of bare trees marked its track through the woods. Finally, the "Army Worm" of the Germans is what we more generally call "Snake Worm," viz., the larva of *Sciara* (a genus of small gnats) which has the peculiar habit of traveling in large

[Fig. 16.]



TENT CATERPILLAR OF THE FOREST: — *a*, eggs; *b*, female moth—natural size; *c*, egg, from top; *d*, from side—enlarged.

[Fig. 17.]



TENT CATERPILLAR OF THE FOREST.

* Identical, as Mr. A. R. Grote first pointed out, with *Aletia argillacea*, Huebn.

bands or armies, all the individuals attached to each other, heads to tails, and the whole mass moving with one impulse, as a unit.*

The species we are now considering is, however, the only one in America which has a just claim to the title, not only because it was first thus christened, but because it so well deserves the name. Known to the scientific world as *Leucania unipuncta*, and often called the Northern Army Worm, to distinguish it from the other species that have usurped its title, this insect has a very extended range and possesses immense power for harm on account of the importance of the crops it devastates.

PAST HISTORY OF THE TRUE ARMY WORM.

"If we trace back the history of the Army Worm in this country, we find that inaccuracy and confusion characterize most of the records concerning it previous to the year 1861. In that year, however, by the contemporaneous observations and experiments of several entomologists, in different sections of the United States, its natural

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* These bands of small worms are of not unfrequent occurrence in Missouri, and I give herewith accounts of them from three different correspondents. In two of the instances the specimens have been sent to me and proved to be identical. The species averages 5½ mm. in length by 0.5 mm. in width, or about a quarter of an inch long and one-tenth as wide. It is a plain, pale-yellow, soft, viscid, semi-transparent, legless worm with a free and brown head, and a slight swelling around the anterior border of the abdominal joints ; the body being cylindrical and tapering but very slightly toward head. Normally these worms live huddled together under the decaying bark of trees, which they leave in adhering bands, when they are full grown and about to enter the ground to transform. When thus marching in trains they are usually pursued by numerous enemies, and especially by rove-beetles (*Staphilinidæ*) and ants. They have been reported from various parts of this country.

From my pear-trees runs a path to my stable. In said path, early this morning, we noticed what we first thought a snake just shed. On closer examination it proved to be a rope-like (about two feet long and ¾ of an inch thick) moving mass of minute worms such as we send you in the center of the enclosed tin box. Could have sent more than a pint. Afterwards in our fruit-garden we noticed apple trees much blighted ; then some of our pear trees died of the same disease. We examined with a knife some of the shoots and found the track and in the track castings of what we thought just such fellows as those massed and marching away from our pear trees. We hastened to the moving rope: it had disappeared, and we could find no traces of the worms, except where they had been trodden into the mud. As we said, this moving column was leaving our pear trees (about fifty) that are dead and dying with blight. In the pear-limbs that we cut off between the outer bark and the wood, we found the track or burrow, castings, etc , and occasionally a worm of the color and size of these migrating bands. We send you with the worms some of the pear limbs from trees that were dying with blight. We never noticed this worm until last season, as above stated, and we had no blight until that time.

Will you please investigate the pear blight and tell us if there is any connection between it and these worms?

Jos. Smith.

Stewardsville, Mo., June 16, 1870.

Of course, as I wrote to Mr. Smith at the time, there is no connection between the worms and the blight, other than that as soon as a tree is blighted, it furnishes under the decaying bark desirable food for them—they being rather the effect than the cause.

In July 1872, Mr. Louis S. Noce sent me specimens identical with those sent by Mr. Smith, with the statement that at Bismarck, Mo., they were travelling together in a roll the size of an ordinary snake.

The third communication about these snake worms in Missouri was made to me last summer by Mr. G. A. Bezoni, of Napoleon, Lafayette Co., under the impression that they might be the genuine Army Worm with which he was not familiar. The species was larger and evidently distinct from the others. He thus describes their appearance:

There were discovered here last summer two rolls of worms, one about six feet long and the other about four feet long They were as large as a large snake, and were traveling from the east. They were so compact and so shaped that they were mistaken for snakes. We got sticks and stones to kill them with, as they were crossing the road, but on striking we found that they were worms, of a grey color and about three-fourths of an inch long.

history was first made known to the world, and the parent moth identified.

"The very earliest record which we find of its appearance in this country is in Flint's 2nd Report on the Agriculture of Massachusetts, where it is stated that in 1743 'there were millions of devouring worms in armies, threatening to cut off every green thing.'

"In 1770 it spread over New England in alarming numbers. Dr. Fitch in his 6th Report quotes the following full and interesting account from the Rev. Grant Power's Historical Sketches of the Coös Country in the Northern part of New Hampshire. 'In the summer of 1770 an army of worms extended from Lancaster, the shire town of Coös county, N. H., to Northfield, Mass., almost the whole length of the Granite State. They began to appear the latter part of July, and continued their ravages until September. They were then called the 'Northern Army,' as they seemed to advance from the north or northwest to the south. It was not known that they passed the highlands between the rivers Connecticut and Merrimack. Dr. Burton, of Thetford, Vermont, informed the author that he had seen the pastures so covered with them, that he could not put down his finger without touching a worm, remarking that 'he had seen more than ten bushels in a heap.' They were unlike anything that generation had ever seen. There was a stripe upon the back like black velvet, and on each side a stripe of yellow from end to end, and the rest of the body was brown. They were seen not larger than a pin, but in maturity were as long as a man's finger and of proportionate thickness. They appeared to be in great haste, except when they halted to feed. They entered the houses of the people and came up into the kneading troughs as did the frogs in Egypt. They went up the sides of the houses and over them in such compact columns that nothing of the boards or shingles could be seen. Pumpkin-vines, peas, potatoes and flax escaped their ravages. But wheat and corn disappeared before them as by magic. Fields of corn in the Haverhill and Newbury meadows, so thick that a man could hardly be seen a rod distant, were in ten days entirely defoliated by the 'Northern Army.' Trenches were dug around fields a foot deep, as a defence, but they were soon filled and the millions in the rear passed on and took possession of the interdicted feed. Another expedient was resorted to: Trenches were cut, and thin sticks, six inches in diameter, were sharpened and used to make holes in the bottom of the trenches within two or three feet of one another, to the depth of two or three feet in the bottom lands, and when these holes were filled with worms, the stick was plunged into the holes, thus destroying the vermin. In this way some corn was saved. About the first of September the worms suddenly disappeared. Where or how they terminated their career is unknown, for not the carcass of a worm was seen. Had it not been for pumpkins, which were exceedingly abundant, and potatoes, the people would have greatly suffered for food. As it was, great privation was felt on account of the loss of grass and grain.'

"The same writer adds that 'in 1781, eleven years after, the same kind of worm appeared again, and the fears of the people were greatly excited, but this time they were few in number.'

"In 1790 their ravages are again recorded in Connecticut, where they were very destructive to the grass and corn, but their existence was short, all dying in a few weeks (Webster on Pestilence, I, 272.)

"Their next appearance in the Eastern States was in 1817, after an interval of twenty-seven years, according to Fitch, who quotes the following paragraph from the Albany (N. Y.) *Argus :*

"*Worcester, Mass., May 22nd*, 1817.—'We learn that the black worm is making great ravages on some farms in this town, and in many other places in this part of the country. Their march is a 'displayed column,' and their progress is as distinctly marked as the course of a fire which has overrun the herbage in a dry pasture. Not a blade of grass is left standing in their rear. From the appearance of the worm it is supposed to be the same which usually infests gardens, and is commonly called the *cut-worm*. * * * This same worm is also destroying the vegetation in the northern towns of Rensselaer and eastern section of Saratoga, New York. Many meadows and pastures have been rendered by their depredations as barren as a heath. It appears to be the same species of worm that has created so much alarm in Worcester county, but we suspect it is different from the cut-worm, whose ravages appeared to be confined to corn.

"It was not until after a lapse of forty-four years from the last mentioned date, namely, in the summer of 1861, that this worm again spread over the meadows and grain fields of the Eastern States. During the interval, however, it had from time to time attracted attention in the Western States, where it often proved quite destructive. Thus, in Illinois, it is recorded as having appeared in 1818, 1820, 1825, 1826, 1834, 1841, 1842, 1845, and 1856, and according to Mr. B. F. Wiley, of Makanda, Ill., it was quite numerous and destructive in the southern part of the State in 1849, and appeared there also in 1857, though it was confined that year to limited localities.* Mr. J. Kirkpatrick, of Ohio, mentions its appearance in the northern part of that State in

**Prairie Farmer*, July 18th, 1861.

1855. He says: 'Last season (1855), in consequence of the heavy rains in the early part of June, the flats of the Cuyahoga, near Cleveland, were flooded. After the subsidence of the water, and while the grass was yet coated with the muddy deposit, myriads of small blackish caterpillars appeared; almost every blade had its inhabitant; no animal could feed upon it without, at every bite, swallowing several; if a new blade sprung up, it was immediately devoured, but what was most remarkable, the insects did not attempt to remove to land a foot or two higher, but that had not been covered by the water.' "*

Since the publication of my second Report I have learned through Mr. M. P. Lentz, of Rocheport, that it abounded in parts of Boone county, in 1854, and this is the earliest record that we have of it in Missouri.

"The year 1861 will long be remembered as a remarkable Army Worm year, for this insect was observed in particular localities throughout the whole northern and middle portion of the United States from New England to Kansas. It was first noticed in numbers sufficient to cause alarm, in Tennessee and Kentucky during the month of April; and toward the close of the same month it appeared in the southern counties of Illinois. By the end of June it had visited nearly all portions of the latter State, proving more or less destructive to grass, wheat, oats, rye, sorghum and corn.

"Its advent in Missouri was simultaneous with that in Illinois, and judging from what facts I have accumulated, it occurred very generally over this State, though recorded only in St. Louis, Jefferson, Warren, Boone, Howard and Pike counties. No mention is made of its occurrence, at this time, in any of the States or Territories west of Missouri, but to the East, scarcely a single State escaped its ravages. In many portions of Ohio it entirely destroyed the hay and grain crops, and in the eastern part of Massachusetts the damage done was reported to exceed a half million of dollars."

In 1865 and in 1866 it attracted attention in restricted localities in Illinois and Missouri. In 1869 it again appeared in vast numbers in many portions of our State, especially in St. Louis, Jefferson, Cooper, Callaway, Henry, St. Clair, Marion, Ralls, and Lafayette counties; also in some counties in Illinois and Indiana. The first intimation I received of its appearance in Missouri was the following letter sent to me by Mr. A. E. Trabue of Hannibal, under date of June 8th:

I inclose a match-box with grass and two worms, which we think are Army Worms. They are here in myriads destroying the grass. Destroyed a hundred acres of blue grass meadow in five days, and are now advancing on me. What are they and their habits?

*Ohio Agricultural Report, 1855, p. 350.

Carbolic acid (one part acid, 20 parts water) kills them if they get a good drench with it, but is too expensive at that rate. They will cross a trail of it without injury, though they evidently dislike the smell. Have sent to town for coal tar to see if they will cross it when the ground is soaked with it. The advancing column is a half mile wide.

The hogs are very fond of them; will not notice corn when they can get Army Worms, but we have more of the latter than they can dispose of.

In 1871 it was reported in the *Prairie Farmer* "Record of the Season" from Marion and Morgan counties in Illinois, and was also abundant in Linn, Louisa, Washington, Appanoose and other counties in Iowa, according to the State Agricultural Report for that year. In 1872 it was more wide-spread, and I received specimens from several correspondents, in Iowa more particularly. It was reported in Louisa, Van Buren, Wapello, Jefferson, Muscatine, Jasper, Washington, Iowa and Adams counties in that State, and very generally in Wisconsin, in Ohio and in Kentucky. It attracted less attention in Illinois and Missouri, though I met with it frequently in the last named State. It was also reported from Tioga county, N. Y. Graphic accounts were likewise published of its devastations in Tennessee, and the *California Farmer* of July 25, 1872, reported legions of Army Worms as appearing over that State spontaneously, and 'stripping vines and potato fields.' From this last statement I infer that they were of some species other than the one we are considering.

But the most interesting manifestation of the insect during the year 1872 was in the vicinity of Peshtigo, in the northeastern portion of Wisconsin. It will be remembered that of the memorable fires that ravaged the northwestern country in the Fall of 1871, none, after that of Chicago, attracted more attention, or caused more sympathy for the sufferers therefrom, than that which swept through Peshtigo, destroying the whole town, and causing numerous deaths and great distress. During July of the following year the people of Peshtigo suffered another infliction in the shape of armies of worms that destroyed the crops and were so numerous that in many places they could be shovelled up by bushels, and fell into wells in such myriads as to render the water foul and useless. This case has such an interesting bearing on the insect's natural history that I shall revert to it again under that head. For the present it is only necessary to say that there can be no doubt as to the species, as specimens received by Dr. LeBaron and by myself showed it to be the insect under consideration. After 1872, until last year, the Army Worm attracted no unusual attention.

ITS HISTORY IN 1875.

During the latter part of May, or just about the time that there was the greatest consternation regarding the locusts, our papers contained dispatches from various parts of Southern Illinois and Central Missouri to the effect that the Army Worm had appeared in countless millions, and was destroying the grain crops at an alarming rate. During the last week of that month Mr. C. M. Samuels of Clinton, Ky., brought specimens to my office with the statement that they were common and doing much damage all over the northwestern portion of Kentucky. It was also reported from various parts of Delaware and of Ohio about the same time. Somewhat later it appeared in Iowa, and I quote the following account of its advent at Fort Madison, from a letter from Dr. A. W. Hoffmeister:

> The Army Worm was very troublesome in some localities near Fort Madison. About the first of June immense numbers of caterpillars, one-half inch long, were observed in low grounds, subject to overflow or standing water. Their eating created a noise which could be heard at a distance as a dull grating or sawing sound. About the 21—24 they bored into the ground and pupated, and in about two weeks after appeared as moths. I had caught the *Leucania unipuncta* in the fall of 1875 and spring of 1876 in great numbers by the process of sugaring, looking at both seasons very fresh; and therefore it is a riddle to me whether there is another brood or whether some pupæ remain dormant till fall or next spring. All my pupæ hatched, but I did not see the moths cohabit, nor did I find young or new larvæ during the summer. This fall the moths are less numerous than last fall.

During the latter part of July and August it attracted attention in New York, and by the middle of the latter month was swarming on Long Island. In September and October it was extensively reported in New England, where it did much injury to Hungarian grass and to oats. Mr B. P. Mann of Cambridge, Mass., who took the moth at sugar as late as October 27, sends me the following extracts which will show the time of year and the numbers in which they appeared in different parts of New England:

> Army Worms are very destructive to vegetation around Mashias [Maine.] There has been nothing like them since 1861. * * * The Army Worms have appeared in large numbers at Colchester, [Conn.] and are doing much damage to the crops. [*Boston Daily Advertiser*, Aug. 10 and 11, 1875.

> The Army Worm appeared in immense numbers on Sunday at Sussex, on the government railway line, east of St. John [N B.], and since that time the ravages have created wide-spread alarm. Fields of grain have been destroyed. Horse rollers run over the road where they crossed did not perceptibly lessen their numbers. A dispatch from St. Andrews says, the Army Worm invaded that town yesterday, covering the streets, fields and lanes in every direction, and devouring the grass and grain in spite of every oppo-ition. They are still advancing. [*Ibid*, Aug. 12, 1875.

> A worm has been discovered in Hollister [Mass.] in such large quantities as to lead to the supposition that it may be the Army Worm again. The army has invaded Delham. They have devastated an acre of Hungarian owned by Mr. Greenwood Fuller, a large field of grass for Mr. Luther Fisher; also for Mr. L. Baker. [*Ibid*. Aug. 16, 1875.

> The south shore [of Mass.] in the vicinity of Black Rock has of late been visited with an innumerable host of moths, commonly called millers. They took possession of rooms which were accessible by the windows being left open, in such numbers that it was the work of days to rid the rooms of their presence. Their origin is a mystery; but they entered rooms facing north in such flocks that it is a theory that they came in from the sea. In one small room 800 were killed. [*Ibid*, September 3, 1875.

ITS HISTORY IN MISSOURI IN 1875.

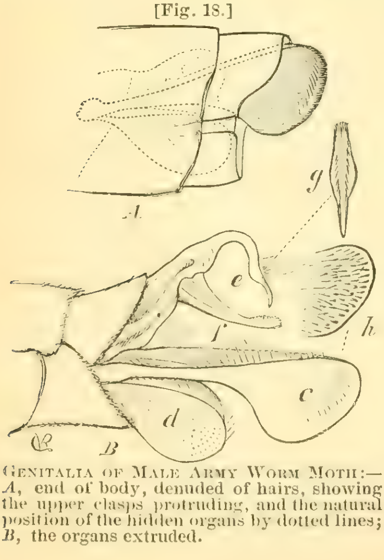
The most noticeable feature connected with the appearance of the worm in our own State was its harmlessness, or non-appearance in the western or locust-stricken portion. Most of these counties are large stock-raising counties, and abound in rich prairie and good meadows. Under ordinary circumstances, the worms would have flourished there; but last spring, though I have records of their appearance, the locusts either destroyed them or caused them to starve before they acquired full growth. The following list of counties in which no Army Worms were noticed or in which they were soon killed out, is made up from reports from my correspondents, and very forcibly illustrates the feature referred to: Andrew, Barton, Benton, Buchanan, Bates, Barry, Caldwell, Clay, Clinton, Cass, Cedar, Daviess, Dade, Dunklin, Grundy, Gentry, Henry, Harrison, Hickory, Holt, Henry, Jackson, Johnson, Jasper, Lafayette, Linn, Marion, McDonald, Macon, Newton, Oregon, Pulaski, Pettis, Putnam, Ray, Sullivan, Scotland, St. Clair, Texas, Taney and Vernon.

In nearly all of the counties not mentioned I have records of its appearance, and often in such numbers that whole fields and meadows were cut down.

SEXUAL DIFFERENCES.

As throwing light on the mode of oviposition the sexual characteristics interest us. The sexes at first glance are not easily distinguished. There are no colorational differences, nor does the abdomen of the one sex differ materially in size or form from that of the other. Yet a careful examination with an ordinary lens will enable one to separate them with sufficient certainty by the smoother antennæ (Fig. 22, *e*) and more pointed abdomen (Fig. 22, *b*) of the female compared to the more hairy or ciliate antennæ (Fig. 22, *d*) and blunter abdomen of the male (Fig. 22, *a*). The antennæ of the female will generally be found quite naked toward the base, while those of the male show two rows of stiff hairs, about half as long as the antennal width. In both sexes the tip of the abdomen is covered with a

[Fig. 18.]



GENITALIA OF MALE ARMY WORM MOTH:—*A*, end of body, denuded of hairs, showing the upper clasps protruding, and the natural position of the hidden organs by dotted lines; *B*, the organs extruded.

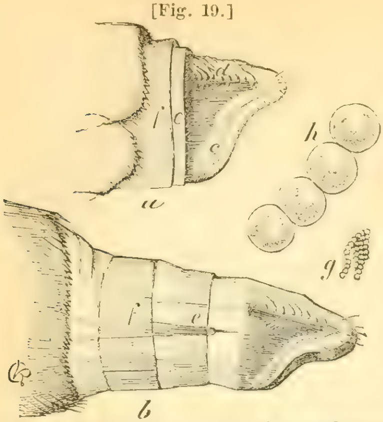
brush of long pale hairs, and the moment these are brushed away the sex is at once easily ascertained. Suppose now we pick out a male for examination! A little friction with a stiff camels-hair brush will soon denude the tip of the abdomen without injuring the horny parts, when we shall notice two rounded, brown, horny lobes or clasps extending somewhat beyond the ultimate joint (Fig. 18, *A*) the lobes some distance apart below, but converging until they touch, above. A careful removal of the chitinous exterior of the two terminal joints will further reveal to us that these lobes are but parts of a somewhat complicated arrangement, admirably adapted for seizing the female, and consisting chiefly of the two lobes referred to, of two smaller, inferior lobes, and of two intermediate organs starting from a knotty base, the upper one curved and ending in a sort of beak, the lower one more straight and ending in a small cushion of contracted membrane above.

A still more careful examination will show that the upper valves (Fig. 18, *c*) have a rather long and gradually narrowing stem, and that they broaden irregularly, the hind border obliquing beneath and the lower border more strongly curved than the upper: all the borders are thickened, the outer surface is polished and dark brown and the inner surface is clothed with stiff, pale, decumbent hairs, replaced toward the posterior portion with brown, retrose spines. (Fig. 18, *h*). The lower valves (Fig. 18, *d*) have a shorter stem and are more regularly rounded: each is composed of two corneous layers soldered and somewhat thickened at the borders, the outer piece easily fractured and detached, pale and covered sparsely with very minute spines; the inner one more solid, darker, and covered with a dense brush of long pale hairs. The upper, intermediate, curved organ reminds one from the side of a swan's neck and head (Fig. 18, *e*): it is yellowish and cylindrical, dilates and enlarges toward the end and terminates in a narrower darker beak, the sides of the dilatation behind are curled up (Fig. 18, *g*) and furnished with long yellowish hairs behind, and the beak with a brush of shorter hairs. The lower organ or penis (Fig. 18, *f*) is broader, composed of membrane supported by two principal ribs—the upper one curved, the lower nearly straight —and ends in a sponge-like, superior swelling, which in life may be considerably extended in the form of a tube. Both those intermediate organs play on a strong horny arch which is generally retracted, but which can be raised and exserted and considerably dilated as in Fig. 18, *B*.*

If we now take a female and denude the tip of her abdomen in the same way, we shall immediately find a quite different and far more simple structure, namely, a thin vertical blade-like valve, more or less produced or elongated on the upper portion, of a brown color, but with a broad, slightly thickened, paler border. This valve plays

* A careful examination of the genital organs of thirteen ♂s of this species shows very considerable variation in the contour, and relative size of all these different parts—so much so as to convince me, when added to my limited examinations of the same parts in other species, that nice differences in these parts alone are of no specific value.

[Fig. 19.]



ARMY WORM MOTH:—*a*, end of abdomen denuded and showing ovipositor at rest; *b*, same with ovipositor fully extended; *c*, *f*, retractile subjoints; *h*, eggs—all enlarged; *g*, eggs, natural size.

into two retractile subjoints of the body, and may be hidden within the terminal joint proper, so as to show only the upper tip, or extended as in the figure (Fig. 19, *a*). It is in reality composed of two thin layers, closely appressed except at the upper or dorsal portion near the base, where it swells into a somewhat angular ridge outside and is hollow within. A more careful examination will show that the upper portion is irregularly and obliquely striate (Fig. 19, *d*), the striations representing folds of the membrane, to facilitate expansion; and that the hind border is garnished with fine hairs which easily rub off and leave the edge quite sharp, so that the two layers form a blade which is admirably adapted to pressing in between narrow passages, or even to splitting frail and hollow stalks. In life this ovipositor plays on the two sub-joints which may be greatly extended, and when so extended forms a somewhat cylindrical and telescopic tube which is rendered very firm by a series of stout muscles within. (Fig. 19, *b*). The valve opens from top to bottom, and may be very considerably distended so as to make way for the oviduct which is a quite complicated structure.

NATURAL HISTORY OF THE ARMY WORM.

Up to the year 1861 our knowledge of the natural history of the Army Worm had remained a blank. Nothing, indeed, of a scientific nature had been published respecting it. "A few very observing farmers ventured to predict its appearance during very wet summers succeeding very dry ones. They did not know why this was the case, but it was a fact that they had learned from experience. It was also known that the worm attacked only the grasses and cereals, that it was gregarious in its habits, and that it disappeared suddenly, in a manner as seemingly mysterious as that in which its advent was supposed to have been made."

In 1861, however, its wide spread occurrence over the country and the large amount of injury it caused, attracted the attention not only of farmers, but of several well known writers on economic entomology and agriculture. Among these may be mentioned my late friends B. D. Walsh, of Illinois, and J. Kirkpatrick, of Ohio; and Prof. Cyrus Thomas, of Illinois, Dr. Asa Fitch, of New York, and J. H. Klippart, of Ohio. Through the efforts of these gentlemen the worm was for the first time connected in our minds with the parent moth, and several parasites were ascertained to infest the species. But beyond these points—important as they are—no discoveries were made. The complete natural history of the species has yet to be recorded. Where facts are wanting theories flourish, and we find that in the *Prairie Farmer*, the *Illinois Farmer*, the *Field Notes* and the *Ohio Farmer*, some very spirited articles were published in 1861 by Messrs. Walsh, Klippart and Thomas — the controversy between the first two being at times personal and acrimonious. The points of dispute between Messrs. Walsh and Thomas were, 1st, whether the insect winters in the egg or chrysalis state; 2nd, whether it is single or double brooded—Mr. Walsh arguing for the first of both propositions. From an economic view these points are of vital importance, and though they have not yet been settled by direct observation, I shall endeavor to settle them, as far as it is possible, by deduction from the known facts in the case that bear on them. Before attempting to do so, it will be well to briefly describe the Army Worm in the three states in which it is known.

[Fig. 20.]

Full grown Army Worm.

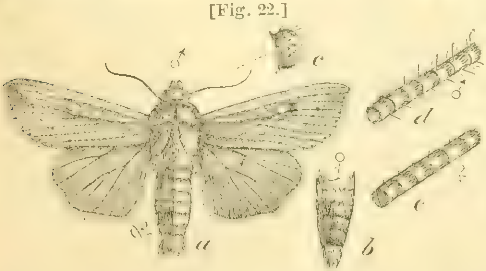
"The general color of the full grown worm is dingy black, and it is striped longitudinally as follows: On the back a broad dusky stripe; then a narrow black line; then a narrow white line; then a yellowish stripe; then a narrow sub-obsolete white line; then a dusky stripe; then a narrow white line; then a yellowish stripe; then a sub-obsolete white line; belly, obscure green. (Fig. 20.)

[Fig. 21.]

Chrysalis of Army Worm.

"The chrysalis (Fig. 21) is of a shiny mahogany-brown color, with two stiff converging thorns at the extremity, having two fine curled hooks each side of them. The general color of the moth is light reddish-brown or fawn color, and it is principally characterized by, and receives its name from, a white spot near the center of its front wings, there being also a dusky oblique line running inwardly from their tips. The accompanying illustration (Fig. 22), will show wherein it

[Fig. 22.]



ARMY WORM MOTH:—*a*, male moth; *b*, abdomen of female—nat. size; *c*, eye: *d*, base of male antenna; *e*, base of female antenna—enlarged.

differs from the Southern Cotton Army-Worm, notwithstanding the colors of the two moths are nearly alike. Our Army moth was first described by the English Entomologist Haworth in the year 1810, in his *Lepidoptera Brittanica*, page 174, as *Noctua unipuncta*. Subsequently the French Entomologist Guenée (*Noctuliètes* I, p. 77) overlooking the former's description, and regarding it as a new species, named it *Leucania extranea*. Of course Haworth's name takes the precedence. It is considered a common species even in European collections, and Guenée mentions it as occurring in Brazil. A variety without the white spot occurs in Java and India, and still another, lacking the white spot, and having a dark border on the hind wings, occurs in Australia; while an occasional specimen has been captured in England. A figure is given in Stainton's Entomologist's Annual for 1860, of one captured there in 1859, but if the figure is a correct one, the specimen is much lighter than ours, and the characteristic white spot is not nearly so conspicuous."*

Whenever this moth is noticed to be unusually abundant in Fall or Spring, the worm may be looked for in the early summer following, and the preventive measures that will be subsequently indicated should be more particularly adopted on such occasions. As of over a hundred correspondents of whom I have asked whether or not they are acquainted with this buff-colored moth, all but six have answered in the negative, and some few have even supposed the Tachina-flies that accompany the worms to be the parents of the latter; I have made a new figure (Fig. 22, *a*) which with the above description will enable the reader to recognize it.

DESCRIPTION OF THE EGG.

An examination of the egg as disclosed in those moths which have the ovaries fully developed, shows it to be spherical, smooth or but very faintly shagreened, with no ribs or sculpture whatsoever. The shell is quite delicate and semi-transparent, apparently of a dirty white or yellowish color. It measures 0.5 mm. in diameter, or about three-hundredths of an inch. In the abdomen these eggs are so closely pressed together in rows (Fig. 19, *g. h.*) that they often present two flat sides from the pressure. I have counted upward of two hundred in a single female, so that the species is quite prolific.

WHERE ARE THE EGGS LAID?

Omne vivum ab ovo—Every creature springs from an egg! Not only from analogy, but from the universality of the law expressed in the foregoing phrase, we could safely conclude with absolute certainty that our Army Worm comes from an egg, even if I had not just dem-

*Mr. Herman Strecker, of Reading, Pa., informs me that he has specimens from New Zealand and Australia, undistinguishable from ours.

onstrated the fact. Further, we may conclude with sufficient certainty that the egg is laid by the parent moth and hatches outside her body. Analogy would also indicate that it is laid on the insect's preferred food-plants; it being a very general law in insect life that the parent, with wonderful instinct, commits her eggs to the plant on which the larvæ or young are destined to feed, if these are herbivorous by nature. Analogy is not, however, an infallible guide, here, for we have seen in the case of the Fall Army Worm that the parent frequently deposits her eggs on the leaves of deciduous trees, which leaves the worms do not feed upon, but from which, upon hatching, they instinctively descend, so as to get at more congenial herbage below (Rep. III, p. 114). Yet there are many recorded facts and observations which indicate that the Army Worm moth follows the more general rule, and that she commits her eggs to the stalks of perennial grasses and of cereals, whether these be cut or still standing.

Nevertheless, the fact remains that no one has ever seen the eggs of the Army Worm moth, naturally deposited;* and even if we admit the correctness of the last conclusion, it still remains conjectural as to whether they are laid within or upon the stalks, single or in masses, in the Summer, in the Fall or in the Spring. Nothing but direct observation will fully and satisfactorily answer these questions; though we may by proper scientific method come to pretty safe conclusions regarding them.

Alive to the importance and interest attaching to these questions, I made every provision last summer that I deemed necessary to their settlement. But "the best laid schemes o' mice and men gang aft a-gley!" Having to leave for Europe just as the worms were entering the ground to pupate, I gave full and explicit directions to my clerk, Mr. Otto Lugger, for carrying on the requisite experiments and observations, with instructions to spare neither time nor means in pursuance of the object in view. The insect was abundant on many farms in St. Louis and Jefferson counties, and everything seemed propitious for fruitful observations. Mr. Lugger proved, by extensive breeding of the moths and attempts to obtain the eggs in-doors, that which I have repeatedly proved in previous years, viz: that the eggs cannot be so obtained. Beyond that, his work was fruitless; for unfortunately the rains in June and July were so frequent and copious, as to materially hinder out-door observations. Search for the moths in fields where the worms had swarmed a few weeks before was so vain as to

*The only purported description of the eggs is by Mr. S. P. Fowler, in a letter to F. W. Putnam, quoted by Mr. C. A. Shurtleff of Brookline, Mass., (Proc. Essex Ins. Vol. III) in his "Report on the Army Worm;" and which evidently refers to *Microgaster* cocoons.

lead to the belief that the insects must have been in great part, if not entirely, drowned out in this locality. In default of direct observation, let us see to what conclusion a careful study of the structure of the insect will lead us.

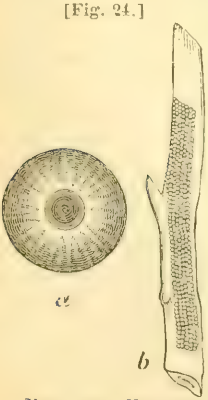
At first view it seems singular that the eggs of an insect that appears in such countless myriads from Maine to Georgia, and from Virginia to Kansas, should have remained undiscovered either by farmers or entomologists. Desiring to attract attention to the subject I offered in the columns of the *Prairie Farmer*, last September, a reward of $20,00 to any one who would send me the eggs of the insect; but no one claimed the reward. One of the obstacles that has stood in the way of discovering these eggs is that, as soon as the worms have multiplied so prodigiously as to attract attention, their natural enemies become so multiplied that a very small per cent. of the worms entering the ground issue again as moths. A second reason is that, during seasons when the insect is not numerous and attracts no attention, no one thinks of searching for these eggs. A third reason is that, as already stated, the moth does not oviposit in confinement. I venture to suggest a fourth probable reason that has, hitherto, occurred to nobody: it is that the eggs are, for the most part, secreted where they are not easily seen. Structure is an infallible index to habit. Look whichever way we may, in studying organic life, we find perfect adaptation of means to ends—special organs to special purposes. To approach at once the subject under consideration, we find the ovipositors of insects, or rather the external parts that shield and guide them, modified in a thousand ways to fit them for conveying the eggs to their destination. Look at the piercing and boring and stinging instruments of the Ichneumons, extending in some instances as in Rhyssa, several inches from the tip of the body! Look at the more or less perfect saws of the Saw-flies which insert their eggs in the tender stems or in the parenchyma of leaves of many plants! Examine the ovipositor of the Cicada and of many of our tree-hoppers, and see how admirably they are adapted to splitting and puncturing twigs! The slender-bodied Dragon-flies belonging to the genera *Æschna* and *Agrion* have an instrument springing from the base of the penultimate joint, composed of four slightly curved horny pieces, the outer pair sharp and notched near the tip, and the inner pair both striate and serrate, so as to perform the three offices of awl, saw and file—the whole admirably adapted for puncturing the stems of water plants. The female of the common Plum Curculio has, lying beneath the pygidium a beautiful horny exsertile spoon-shaped contrivance, with a decurving point, wherewith to guide her egg beneath the skin of the punctured fruit. The reader of these reports needs not to be told how admirably the ovipositors of the different Katydids are adapted to splitting the thin edge of a leaf, to penetrating a twig, or to rasping the same, according to the manner in which the eggs are laid; nor need he go beyond the case of the locust, with her drilling valves for an example of the same admirable adaptation. To come to moths, let me illustrate by a few examples taken alike from these reports. Mark the sword-like sheath and the extremely acute, wirey, elastic, thread-like organ (Rep V, Fig. 74, *j*) which is to convey the egg of the Yucca Moth to its destination through the tender flesh of the forming fruit: the horny, telescopic process (*ante* fig. 9, *i*) that enables the Spring Canker Worm Moth to thrust her eggs into cracks and cavities and beneath close-lying scales of bark! The ovipositor of the Stalk Borer (*Gortyna nitela*, Rep. I, Fig. 35) which in the larva state burrows in the stem of the Potato and of a variety of other plants, ends in a pair of horny nippers which open laterally (Fig. 23.) When closed they form a wedge which seems admirably adapted to prying between a terminal leaf bud or into the tender union of leaf with stem, and it is more than probable that the eggs are so placed. That of the Fall Army Worm, the eggs of which are laid in exposed masses and covered with down, is a mere fleshy, slightly bifid protuberance, generally hidden altogether out of sight in a dense mass of soft scales and down, which fills the end of the abdomen and which is easily detached and used in oviposition by merely rubbing against the surface on which the eggs are being laid, and perhaps also by the use of the bifid ovipositor for that purpose. In detaching the rather abundant pale hair that adorns the end of the abdomen outside, one is surprised at the profusion of black and gray downy matter that crowds the inside.

[Fig. 23.]

OVIPOSITOR OF GORTYNA NITELA:—*a*, showing it excerted from tip of abdomen; *b*, showing it from above.

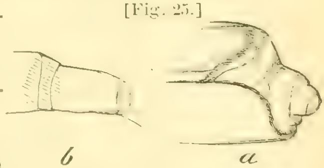
If we examine that of the parent of the Variegated Cut-worm—the Unarmed Rustic (Rep. I, p. 72,) the eggs of which (Fig. 24) are exposed and not protected with any covering, we shall find that it also is a mere fleshy, retractile tubercle (Fig. 25) capable of slight elongation. This last may be taken as an example of the typical form of ovipositor in all moths

[Fig. 24.]



EGGS OF UNARMED RUSTIC:—*a*, top view; enlarged; *b*, a batch natural size.

[Fig. 25.]



OVIPOSITOR OF UNARMED RUSTIC:—*a*, as it appears at end of abdomen; *b*, when extended.

which lay their eggs unprotected in exposed places; and wherever there is any great modification of it, we may feel sure that it is for some special purpose, and indicates some other than the ordinary mode of oviposition. Now if we study the structure of the ovipositor of *Leucania* as exhibited on page 32, we shall find that it is admirably adapted either to clasping the edge of a grass-blade or of a slender glass-stem, and attaching the eggs in rows therealong, or still better to pressing in between and then widening long and narrow passages, such as occur between the sheath and stalk of grasses and grains, especially just above the joints. It might even be used for splitting the more fragile, yielding and hollow stalks of grain, and of some of the tame grasses, though it evidently could not be inserted into the more solid and pithy stalks of most wild grasses. It is my belief, therefore, that the eggs of the Army Worm are secreted for the most part between the sheath and stalk of its food plants just above the joints. European observations do not help us much in forming any opinion; for the eggs of no species of the genus seem to have been observed. The fact is well known, however, that the larvæ of those species which frequent more particularly aquatic grasses and reeds, often retreat and live within the stems; while other insects of the same family, and notably those of the very closely allied genus *Nonagria* naturally live within the stems of reeds and flags. I find upon examination of such European species as I have been able to observe (*impura* Albin and *lithargyria* Esp.) that the ovipositor is constructed after the same plan, as are also those of our other American species of the genus; the difference, when there is any, being in the more pointed upper portion and lesser prominence of the rounder, lower portion of the valve. These facts lend some further weight to the deductions I have drawn.

There are many good reasons, also, for believing that perennial grasses are preferred by the moth, and that the eggs are seldom consigned to the stalks of annuals. From about 130 practical and intelligent farmers living in different parts of Missouri, to whom I have directly put the question: " What is your experience as to where the eggs of the Army Worm Moth are laid?" the large majority reply that they have made no observations and have no knowledge. A number give it as their opinion (and it is undoubtedly a correct one) that the eggs are laid in grass that has not been pastured and in old meadows; a smaller number that they are laid in oats stubble; still others that they are laid in old straw stacks; and a few that they are laid in the ground in sheltered and moist places. These opinions are founded not on any direct observations on the eggs, but on the localities from which the worms were noticed to come last spring; and as the experience of some of my correspondents on these points is interesting, I give a few extracts herewith:

First noticed on low and level land—[Dr. A. H. Dye, Lamar, Barton county.

On level land; the opinion prevails here that they were most numerous on land that had been previously cropped to oats or Hungarian grass—Wm. H. Avery, same place.

First noticed in old meadows—[S. S. Smith, Bertrand, Mississippi county.

My opinion is that they originate in wet meadows—[J. M. Anthony, Fredericktown, Madison county.

In every instance, so far as we have been able to observe in this neighborhood, they came from the stubble near and among the roots of the grass in meadows; and they were noticed about the roots of the grass when as small in diameter as the finest needle—[Robt. E. Caskie, Rocheport, Boone county.

All whom I have spoken to describe them "to seem to just come out of the ground in *old meadows*, regardless of high or low situation." In some instances they came from old straw stacks, 2 years old.—[Wm. Riehl, Potosi, Washington county.

There were some Army Worms in a few localities in low meadow land in this and the east edge of Callaway county.—[E. R. Brown, Montgomery City, Montgomery county.

The worms hatched in low meadows first, and afterwards on higher lands, such as meadows and wheat fields, and in some instances they hatched in fields planted in corn.—[Henry Bruihl, Appleton, Cape Girardeau Co.

On low land.—[S. S. Bailey, Dundee, Franklin Co.

Noticed on both high and low, but were far more numerous on low meadow lands. No prairie here. They seemed to come from wheat straw cut in June and trashed in October; timothy cut in June and July, old dead weeds, and trash of all sorts that had lain over winter seemed their native home. Pastures or meadows pastured bare previous Fall, were not infested.—[Wm. Carr, Belleview, Iron Co.

They were first observed on high land and appeared in our flower garden, where we had used considerable straw and trash as a mulch.—[W. S. Goodman, Mt. Vernon, Lawrence Co.

On the farm of Mr. Henry Elliott, joining my wheat, are extensive Timothy meadows and old pastures of the same of twenty years standing, all of which were ruined so far as the then growing crop was concerned. Certainly they must have been bred in those meadows and pastures; if not, I know not from whence they came. High and low lands were alike infested. A few seemed to start from woodland pastures where stock fodder had been fed twelve months before, making their way into growing corn near by. This I observed in two places half a mile apart.—[Thos. Mitchell, Boonville, Cooper Co.

I think their appearance as a general thing was first in low lands, but in a very short time they spread over the hill lands as though they all came up out of the ground at once. They were most destructive near old straw piles.—[J. B. Douglass, Columbia, Boone Co.

In every old hay or straw stack place there were more or less of them, and to such an extent did they come from such places, that such places were fired to destroy them. On our place there were but few, and those from hay stacks; the hay was cut the latter part of the June preceding.—[L. A. Brown, Boonsboro, Howard Co.

There were none noticed on the upland in this county, but they were very numerous on creek bottoms in the southern part of the county.—[D. P. Dyer, Warrenton, Warren Co.

A piece of my farm was adjoining a straw rick, some of which was from the crop of '73, some from '72, and I am thoroughly convinced that the Army Worm has its origin in old straw piles. Many fine meadows in the county were entirely destroyed by them, and in every instance, upon inquiry, I found they could be traced to the old ricks of straw contiguous to the meadows. They would pass from meadow to meadow, going through fields of wheat, eating only the cheat.—[F. M. DIXON, Jefferson City, Cole Co.

They invariably hatch in low lands or in or about old straw yards and low prairies. They do not seem to inhabit high lands, or visit them as frequently as low grounds.—[ELIHU CANADAY, Jones City, Pettis Co.

The above experience accords with that of a large number of persons who have observed the insect in years past; and from it we may conclude, 1st, that the moth lays her eggs in standing grass and grain stalks, but also in such as have been cut and made into stacks and ricks.

WHEN ARE THE EGGS LAID?

This question can only be answered in a positive manner when that we have just been considering is definitely settled. Nevertheless, we have facts enough to warrant our drawing conclusions with sufficient confidence. Practically the knowledge of the time of deposition is almost as important as that of the place. There have been, and can well be, but two opinions, viz., that they are laid either in the Spring or in the Fall. Every one who has had anything to do with the rearing of this moth or who has given any attention to it, knows that in the latitude of St. Louis, it issues on an average in from two to three weeks after the worm enters the ground. In this latitude they may be taken abundantly at sugar, from the middle of June to October. During all this time they may be noticed, when abundant, in our pastures and meadows, and especially in such as are rank and undisturbed. They have a strong flight, and in alighting dash down into the grass, apparently without any caution, and from observations which Prof. Thomas made last summer, it would appear that they mostly fly close to the ground and ascend but a few feet, since, though they were common about his residence, none reached his bed-chamber on the second floor. My own experience accords with this. The most interesting feature about this moth in the present connection, is that the ova are without any appreciable development at the time of issuing, for which reason, as I have already stated, I have always been unable to obtain eggs in confinement. By pressing the abdomen so as to extrude to their utmost the telescopic joints on which the ovipositor plays, the ovaries will issue from the lower part of the valve in the form of two little white sacks. A week after the moth issues the eggs are only just discernible in these sacks, like so many little specks all very regularly and beautifully arranged.

In order to throw light on the question under consideration, I have dissected and carefully examined a large number of female moths from different parts of the country, and would right here tender my thanks, for their readiness in furnishing material from the localities where they reside, to the following gentlemen: A. J. Packard, Jr., Salem, Mass.; H. A. Hagen, Cambridge, Mass.; J. A. Lintner and Otto Meske, Albany, N. Y.; Hermann Strecker, Reading, Pa.; A. W. Hoffmeister, Fort Madison, Iowa; A. Bolter and O. S. Westcott, Chicago, Ills., and Cyrus Thomas, Carbondale, Ills. The result of these examinations proves that several weeks must elapse from the time the moth first appears before she can lay eggs. I have found these fully developed in only three specimens, one obtained of Dr. Hagen, and captured in Maryland (time not known) and two taken by myself in St. Louis county, in the month of September. They have fair development in some of the specimens taken during the same month in Chicago and New York, whereas in most of the specimens I have examined—many of them taken as late as August and September in Iowa, New York and Massachusetts—the eggs have been found very immature. This has likewise been the case with the few that I have been able to examine that were captured in the Spring. I am inclined to think that this is owing to the fact that most of the specimens in the cabinets of entomologists are fresh specimens, either bred in-doors and killed soon after issuing, or taken at sugar. There can be little doubt that the moth lives several weeks, or even months. Its tongue is very stout and by it the moth can perhaps obtain nourishment from the moisture and juice from the tender base of grass stalks,* as well as from the nectar of flowers. It naturally seeks rank grass plots, swamps or prairies, and once there would hardly be attracted to timber where sugaring is generally carried on.

In my second Report I stated my belief that in this latitude the bulk of the eggs are laid in the Fall of the year, and only the exceptional few in the Spring. This opinion was based on a large amount of testimony that might be cited to show that the worm never hatches the same year on land that was ploughed late in the Fall or in the Spring, or in grass or grain sown in Spring,† and that where meadows or grass plots have been burned in winter, they have been exempt from the ravages of the worm, while non-burned and adjacent grass has swarmed with it; also on the further fact that, so far as my experience goes, the moths are more numerous in the Fall than in the

* The Germans apply the term "honey-sweating" to some grasses.

† The testimony on these points is conclusive, as any one can see by carefully perusing the Report which B. D. Walsh published on the insect in the Transactions of the Illinois Natural History Society for 1861. In 1875 the same facts were observed, and Mr. C. M. Samuels, of Clinton, Ky., reports to me that all over that country where the worms were bad in May, they came from low grass lands, and that they never occurred on lands broken the previous Fall, though often abounding right along side, on unbroken lands.

Spring. But upon reflection we shall find that the first class of evidence does not preclude their being laid also in Spring; for if, as I believe, the moth oviposits by choice in mature grass, hay and stubble, the burning and plowing of fields would equally deprive her of the favorite nidus. The greater scarcity of the moths in Spring may, also, only be apparent, and due to the fact that they are more busy ovipositing. From the examination of over 50 females caught in the Fall—only 3 of which had well developed eggs—as well as from the many other considerations brought forward in this article, I am now more inclined to believe that the bulk of the eggs, even in this latitude, are laid in Spring, or early in the growing season, and that the smaller proportion are laid in the Fall. That such is the case further north, is pretty certain. The further north we go, the fewer eggs will be laid in the Fall.

Exceptional and abnormal occurrences often help us very materially in such questions as these. The remarkable appearance of the worm, as already described (*ante*, p. 28) in and around Peshtigo, Wisconsin, in the year following the memorable fires that swept over that country in October, 1871, was very interesting in this connection. The conflagration was very general, and occurred so late in the season as to preclude the idea that the eggs were subsequently laid that same Fall. It is barely possible that many of the eggs may have escaped, for though in some places the heat was sufficient to cook potatoes two or three inches under ground, in others grass and grain in low places, though scorched, were not materially injured, and these are just the places were the Army Worm eggs are most likely to be laid. But after taking much pains to get at all the facts, I believe that the Peshtigo experience proves conclusively that in that higher latitude the bulk of the eggs are laid in the Spring. The following letter from Mr. A. J. Langworthy, of Milwaukee, is interesting as giving particulars and dates:

The worm appeared about the 1st of July, and originated on the low, swampy lands, soils evenly burned, which abound in small patches all over the burned district. The territory burned over was before the fire at least three-fourths woodland, and a comparatively wild country, with no prairie at all. No part of the country invaded by the worm escaped the disastrous conflagration, which did its work on the 9th of October, 1871, at night, at the same time with the Chicago fire, and was followed by moderate rains very soon after, which extinguished most of the burning embers. By the 20th November following winter had set in with snow which did not disappear in the woods until the following April. I should say that the ravages of the worm about Peshtigo were confined to an area not exceeding 4 by 6 to 8 miles—and that they originated on the low grounds that had been formerly covered with a dense growth of white cedar, which is the case in all these swampy indentations. * * * Not *one-half inch* of rain had fallen in the doomed territory, from the 1st of May until after the fire in the Fall, so that the extraordinary drouth may have been favorable to the propagation of these insects. The worms in their line of march, through the "sugar bushes," a little west of where the village of Peshtigo stood, devoured everything in their course, even to the corn and onions, filling the wells, houses and barns of the few inhabitants, and driving them in dismay from beyond their presence.

We may justly conclude, therefore, that the disputants who have been contending, on the one hand for the Fall and on the other for the Spring oviposition of the Army Worm Moth, have, as in so many other cases of like nature, both been right and both been wrong. They were looking at the same shield from opposite sides. I am very much inclined to believe that whether the moths preponderate in Spring or Fall, even in the vicinity of St. Louis, depends much upon the character of the seasons. A large experience in rearing insects points conclusively to the fact that a certain amount of moisture is requisite for the proper development of all species that transform in the ground in a simple cavity; and that during excessive drouth pupæ so situated will remain dormant and unchanged for weeks, when a single moistening of the ground will revive them, permit the retarded transformation and release the imago from its parched prison.

IN WHAT STATE DOES THE INSECT HIBERNATE?

This question is intimately connected with the preceding one, and, like it, will not admit of a single unqualified answer. Accepting as facts that the eggs are laid both in Fall and Spring, the following questions are to be considered: 1st, whether the eggs laid in Autumn hibernate as such, or whether the larvæ first hatch and hibernate while small; 2d, whether those laid in Spring are by moths which issued at that season, after hibenating as chrysalides, or by such as issued the preceding Fall and hibernated as moths.

As bearing on the first question it is interesting to note that the European species of the genus, so far as their habits are known, hibernate in the larva state. Thus *Leucania lithargyria* Esper, and *L. turca* (Linn.) hibernate as young larvæ, while *L. comma* (Linn.) winters as a full grown larva, according to Speyer. Quite a large proportion of our closely allied cut-worms are, also, known to thus hibernate. It would seem, therefore that, in default of direct observation, we have no good reason for assuming that the eggs laid in Autumn necessarily hibernate as such. But while these analogies make it probable that the insect may winter in the larva state, all the other facts point to the conclusion that the proportion that so winter, if any, is very small. Instead of abounding in a wet Spring when their favorite haunts are overflowed, they would be well nigh drowned out, on the hypothesis that they had been wintering there as larvæ. As bearing on the second question we have certain facts which indicate that some of the pupæ hibernate, the proportion doubtless increasing as we go north. I have myself never had any of the worms remain in chrysalis through June, but Prof. Thomas records that less than half of the pupæ which he caged hatched out, and that "only a part are transformed to moths during the season of their larva state."* Unfortunately he has left no record of rearing the moths from those chrysalides the following Spring, and we do not know to how large a degree the non-issuance of the moths was owing to unfavorable conditions in the breeding cage, which so often affect insects reared in confinement, and which every rearer of insects is so familiar with. But Mr. Otto Meske, of Albany, N. Y., informs me that he once found a chrysalis about the middle of May which in a few days gave him the genuine *unipuncta*, and the earliness of the date precludes the possibility of the worm having been hatched the same Spring in that latitude, and renders it almost certain that the pupa hibernated. Of more value still is the earliness of appearance and freshness of most of the moths captured in Spring—indicating that they have just come from the ground. These facts might, it is true, be explained by the larva hibernating partly grown, but the Peshtigo experience is valuable here and renders the other conclusion much the most plausible. In fact the hibernation of a certain proportion of the pupæ finds its parallel in numerous other instances in the lives of moths that might be mentioned. Every experienced entomologist is aware that with lots of species the imagos from the same batch of larvæ often issue partly in Fall, partly in Spring; while I have given instances in previous reports of still greater irregularity. The worms that attract such attention, about the time our wheat is ripening by marching from field to field are mostly full grown. These would naturally soon turn to moths; but it must not be forgotten that they are the earliest developed and that the younger and weaker ones have mostly been obliged to succumb in the struggle for individual mastery, which must have preceded the forced abandonment from sheer hunger, of the original fields where they were born; and that, further, in fields and rank places where the worms are not so numerous as to be obliged to travel, there are individuals maturing for several weeks after the more noticeable hordes have vanished out of sight. As to the hibernation of the moth, having shown that the larger proportion of the moths captured in Autumn have the ovaries yet quite immature, it is pretty evident that the insect hibernates in this state, and I learn from Mr. Strecker, that he has in fact, found the moth in February, hibernating under clap-boards at Reading, Pa., while Mr. B. P. Mann, of Cambridge, Mass., has also found it hibernating. It would be unreasonable to assume that such large numbers of the moths as occur in Autumn are destined to perish without issue. Moreover, a large number of closely allied moths are known to hibernate, and this mode of hibernation

Illinois Farmer, Sept. 1861, pp. 271 & 272.

will explain more of the known facts in the insect's economy than any other.

From the foregoing considerations I think we may safely conclude that—taking our whole country with its varied climate—there is no one state in which the Army Worm can be said to solely pass the winter; that according to latitude and the character of the seasons, there is nothing to preclude its hibernating in any one of the four states in which it exists; that in the same latitude and under the same conditions it will even hibernate in different states; and that, finally, the great bulk of them hibernate in the pupa and moth states, the proportion of the former increasing northward.

HABITS OF THE WORM.

The fact cannot be too strongly impressed on the mind, that the traveling of the worms in large armies is abnormal. During the latter part of April and throughout the month of May, in this part of the country, the worms may almost always be found by diligent search in moist grass land that was not cut or grazed too closely the previous Autumn. At these times they have essentially the habits of ordinary cut-worms, and are seldom noticed unless so abundant as to cut the grass entirely down and be obliged to travel to fresh pastures. Indeed, one may pass daily through a grass plot where they abound, and never suspect their presence until the plot suddenly begins to look bare in patches; and Prof. Thomas tells me that though he was particularly looking for the worms last June, he never suspected their presence in a constantly frequented grass plot behind his house, until it was made manifest in this way, by which time the worms had mostly disappeared, the abundance of their excrement, however, showing well enough that they had been there.

The reasons why they so easily escape detection in this their normal condition, were made very obvious to me in the early part of May, 1872, when I had an excellent opportunity of studying them. When less than half an inch long, the worms are scarcely recognizable as Army Worms, the characteristic dark, sinuous lines on the head being at this time obsolete and the general color being pale green. The color is very variable at any stage of growth, and in some individuals the brown predominates while they are yet quite small; but up to the last molt the green generally prevails and the longitudinal dark lines are less conspicuous. The broad stigmatal line is the most persistent, being distinguished when the insect is ¼ inch long. The worms in this their normal condition feed mostly at night and hide during the day at the base of the grass or under any other shelter at hand. If they venture to mount a plant and feed during the day—which they often do in cloudy weather—they drop at the least disturbance, and curl up in a spiral so as to simulate very closely a small shell of the *Helix* form. The worm loves cool, moist places, and is more often found around the margins of creeks and ponds than elsewhere. Last year when the rains were so copious as to fill creeks and bottom lands and float numbers of the worms away, I saw many an one cling tenaciously to grass blades and continue feeding as though little concerned, even when partly immersed.

As already intimated, it is only when hunger impels them that they march forth from the fields where they were born, though after they have once begun the wandering habit they often pass through fields without eating everything to the ground. Invariably when the older individuals are attracting attention by congregating and traveling in armies, others may be found of all sizes in the more normal and quiet condition in grass that is yet sufficiently rank: they may indeed be found some time after the first worms have changed into moths; and the mower with his scythe often startles the moths in numbers during the latter part of June, while yet the worms are clinging to the grass that he is cutting, or hiding in the stubble that he leaves.

When traveling the worm "will scarcely turn aside for anything but water, and even shallow water-courses will not always check its progress; for the advance columns will often continue to rush headlong into the water until they have sufficiently choked it up with their dead and dying bodies, to enable the rear guard to cross safely over. I have noticed that after crossing a bare field or bare road where they were subjected to the sun's rays, they would congregate in immense numbers under the first shade they reached. In one instance I recollect their collecting and covering the ground five or six deep all along the shady side of a fence for about a mile, while scarcely one was seen to cross on the sunny side of the same fence."

While most of the worms burrow into the ground and form a simple cavity a few inches below the surface, in which to undergo their transformations, many of them transform beneath loose stones, slabs of wood, matted grass, or any other shelter afforded.

TIME OF APPEARANCE OF THE WORM.

As this varies according to the character of the season and according to latitude, the only safe general statement that can be made is that the bulk of the worms are full grown and do the greatest damage about the time that "wheat is in the milk." This is also the time when they first attract attention as, though they hatch three or four weeks earlier, they are previous to this time not easily noticed for reasons just stated. In ordinary seasons they are reported along the 32nd parallel, as in Texas, early in March, and about a week later with each degree of latitude as we advance northward. Thus in South Missouri they commence to march about the middle of May; in Central Missouri the first of June, and in the extreme northern part of the State about the middle of the month. In the more northern New England States they seldom do much damage before the middle of July. There may, therefore, be a difference of over two months between the appearance of the worms in Southern Missouri or Kentucky and in Maine. Thus early in June of the present year, when I left home, they were mowing down the meadows and wheat fields in Central Missouri and in Southern Illinois, Ohio, Indiana, as well as in Kentucky; while upon arriving in New York two months later, they were marching through the oat fields of Long Island, and were reported very generally in the Eastern States. In Maine they appeared as late as September.

ARE THERE ONE, OR TWO BROODS EACH YEAR?

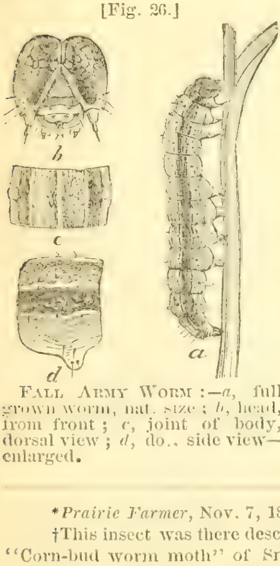
All the evidence, and the whole history of the insect as here set forth, point to its one-brooded character, at least in ordinary seasons, and north of the 38th parallel. In the more northern States, it is evident, from the lateness of the season when the worms enter the ground, that those which issue as moths the same season cannot beget a second brood, since the ovaries are so immature at the time of issuing. There is in fact no actual evidence of its 2-brooded nature. One of the arguments brought forward in support of the theory, is that it is difficult to conceive how an insect that produces but one brood annually can become at times so prodigiously multiplied. But it is only at long and irregular intervals that it does become so prodigiously multiplied, and after such a wide-spread appearance of it in our cultivated fields as that of 1875, it takes several years of undisturbed and unnoticed multiplication, culminating in unusually favorable conditions, before the decimation of its ranks that inevitably follows such undue increase, is repaired, and this notwithstanding its great prolificacy. It is an interesting fact, also, that most Lepidopterous insects that have a wide geographical range and the peculiarity of appearing suddenly and at irregular intervals in vast swarms, are known to be single-brooded; while most of our cut-worms, its close allies, I have by experiment proved to be so. The second argument in support of the 2-brooded nature of our Army Worm is, that accounts are often heard of the Army Worm appearing in the Fall of the year, but in every instance where I have been able to obtain specimens for examination, they have proved to be

THE FALL ARMY WORM.

This worm not only acts at times like the Army Worm proper, but bears a very close general resemblance to it, so that it is not surprising that the two insects should have been so often confounded. Reports of the appearance of THE Army Worm in the Fall, such as that recorded by Prof. Thomas, and which greatly influenced him in his belief that our Leucania was double-brooded,* are easily explained by what we now know of this Fall species. Having already given an extended account of this last in my 3rd Report,† it will suffice in this connection to repeat the leading facts in its history, so as to show how it may be distinguished from the Leucania.

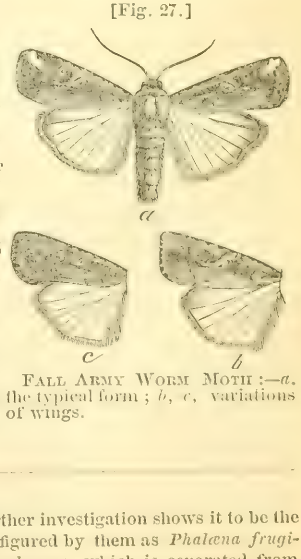
The Fall Army Worm—unlike the Leucania, which confines itself for the most part to grasses and cereals—is a very general feeder, devouring with equal relish most succulent plants, such as wheat, oats, corn, barley, grasses, purslane, turnips, most garden vegetables, and even spruces. Though variable in color, when carefully examined it will be found to invariably differ from the Army Worm in the following more noticeable points: 1. It never becomes quite so large; 2, the head is smaller, darker, with a conspicuous white, V-mark, not possessed by Leucania; 3, the lateral dark and pale lines are broader and the former bordered above by a much more distinct white or yellowish, narrow line; 4, the piliferous spots and hairs, which in Leucania are so obsolete that the worm appears perfectly smooth, form conspicuous polished black tubercles that give rise to short, stiff, black hairs. Compare figs. 20 and 26, *a*. Thus, whenever worms are found mowing down grain in the Fall of the year, the presence of these easily observed black tubercles will at once show that they are not the genuine Army Worm. The moth, which belongs to Guenée's Family

[Fig. 26.]



FALL ARMY WORM:—*a*, full grown worm, nat. size; *b*, head, from front; *c*, joint of body, dorsal view; *d*, do., side view—enlarged.

[Fig. 27.]



FALL ARMY WORM MOTH:—*a*, the typical form; *b*, *c*, variations of wings.

***Prairie Farmer*, Nov. 7, 1861.

†This insect was there described as *Prodenia autumnalis*. Further investigation shows it to be the "Corn-bud worm moth" of Smith & Abbott, (Ins. of Ga., 96) figured by them as *Phalæna frugiperda*, and subsequently described by Guenée under the genus *Laphygma*, which is separated from *Prodenia* by a few rather trifling characters.

Apamidæ, is totally unlike our Leucania, being smaller, and of a mouse-gray color, with the hind wings glistening-white. Though so variable that scarcely any two are alike, they may yet be separated into three distinct sets or varieties. The first which may be considered typical is shown at Figure 27 *a*, the second which I have called *fulvosa* at *b*, and the third which I have called *obscura* at *c*. The eggs are deposited in small clusters, often two or three layers one above the other, and covered with downy hair from the parent's abdomen. Each egg has the form of a slightly compressed spheroid, faintly ribbed, and is dull yellow in color. As already stated (p 35) they are often laid on the leaves of trees on which the larva does not feed.

PLANTS PREFERRED BY THE ARMY WORM.

Though when hard pushed the worms will fall upon and devour each other, and—if the Peshtigo reports in 1872 are reliable—will take even onions, and other vegetables, and, according to B. F. Wiley, of Makanda, Ills., who is reliable authority, the leaves of fruit trees;* yet their attacks are mostly confined to grasses and cereals, and it is extremely doubtful whether they could live for any length of time on other plants. Their more natural food-plants are the coarse swamp grasses. Of cultivated crops they do most injury to timothy and blue grass meadows and winter wheat. Though they nibble at clover, they evidently are not fond of it and generally pass it by. Rye is also not as palatable to them as some of the other grasses.† They often cut off the ears of wheat and oats and allow them to fall to the ground, and they are perhaps led to perform this wanton trick, by the succulency of the stem immediately below the ear. South of latitude 40° they generally appear before the wheat stalks get too hard, or early enough to materially injure the crop; but north of that line, wheat is generally too much ripened for their tastes, and is sometimes even harvested before the full grown worms make their advent.

The worm sometimes passes through a wheat field when the wheat is nearly ripe, and does good service by devouring all the chess and leaving untouched the wheat; and the following items would indicate that even a foe to the farmer as determined as this, may sometimes prove to be his friend.

HARVEST AND CROPS.—Notwithstanding the unfavorable weather, many farmers have commenced the wheat harvest. The yield in this immediate vicinity will be superabundant. Some fields were struck with rust a few days since, but the Army Worm making its appearance simultaneously, stripped the straw entirely bare of blades and saved the berry from injury. These disgusting pests have saved thousands of dollars to farmers in this neighborhood. A few fields of corn and grass have been partially destroyed, but by ditching around fields, the worm's ravages have been confined

* *Prairie Farmer*, July 18, 1861.

† Jno. Monteith, the present Secretary of the Board of Agriculture, had two acres of timothy, sown in 1874 with rye. The worms last year cleaned out the timothy, but did not materially affect the rye.

within comparatively narrow limits.—[Collinville, Ills., correspondence of *Missouri Democrat*, June, 1869.

Mr. Ed. Dixon informed us Saturday that the Army Worm had destroyed twenty acres of timothy for him. From the meadow they entered the wheat field, and destroyed every stalk of cheat, leaving the wheat unhurt. Mr. Dixon ditched between his wheat and corn-field, and with the aid of a dozen or two pigs succeeded in arresting their progress and destroying them. This is about the experience that many farmers have had in this county. They can be prevented from doing harm by determined, vigorous opposition.—[Jefferson City *Tribune*, June 16, 1875.

The habit of merely stripping the blades off the wheat stalks was very general last summer, and a large number of farmers report that the work of the insect was beneficial to wheat, as the rains were very constant and copious and the grain denuded of its leaves ripened better than it otherwise would have done.

ITS SUDDEN APPEARANCE AND DISAPPEARANCE.

Among the manifestations in lower animal life, few are more astonishing than the sudden occurrence of a species in vast numbers over large stretches of country, and its as sudden disappearance. In a few rare instances, as with the thirteen and seventeen-year Cicadas, these manifestations are strictly periodical, and occur at regular intervals; but in the great majority of instances they have no such periodicity. The numerous natural checks which surround every animal, added to the meteorological conditions which affect it in its "struggle for existence," sufficiently explain these phenomena to the intelligent naturalist, though it is not always easy to point out the facts in specific cases.

Under the head of "Habits of the Worm," I have already given the reasons why it escapes attention in its earlier stages and in seasons when it is not excessively abundant. If, as from what has gone before we may justly conclude, the natural abode of the worm is in our low prairie lands and swampy places, it follows that during a very dry season, when such lands dry out, the worm has a wider range than usual, where the conditions for its successful development are favorable.

It is a well established fact that all great Army Worm years have been unusually wet, preceded by one or more exceptionally dry years; and the wide-spread appearance of the insect in 1875 formed no exception to the rule. The explanation of this fact originally given by Dr. Fitch,* is beyond doubt correct in the main, but needs further elucidation. Dr. Fitch's views, in his own words, are given in the following paragraphs:

The Spring and early summer of this year [1861] was exactly the reverse of last year—unusually wet, and the water high in all our streams. Hereby the swamps have all been overflowed, and this insect has been drowned out of them. [1] The moths or millers on coming out of their chrysalides, found it was impossible for them to get to the roots of the grass there, to deposit their eggs. They were obliged to forsake their usual haunts and scatter themselves out over the country, the incessant rains making it sufficiently wet everywhere to suit their semi-aquatic habits. Thus going forth in

*6th N. Y. Rep., 121.

companies, they alighted in particular spots, and there dropped their eggs; and the result is sufficiently well known.

More briefly expressed my view is this: a dry season and dry swamps multiplies this insect. And when it is thus multiplied, a wet season and overflowed swamps drives it out from its lurking place [2] in flocks, alighting here and there over the country. But on being thus rusticated, it finds our arable lands too dry for it; and immediately on maturing and getting its wings again, it flies back to the swamps, whereby it happens that we see no more of it.

[1] It stands to reason that if the insect were drowned out by overflowed swamps, a wet season, instead of being favorable to its wide dispersion, would check its increase and almost annihilate it: what is meant is, doubtless, that the moth is driven out of the overflowed swamps.

[2] This necessarily implies that the moths either issue in the Fall, and winter over, or else in the Spring before the rains have overflowed the low places; for if the overflow take place while yet the pupæ are in the ground or after the eggs are laid or the worms hatched, it must needs prove detrimental by drowning them out. Thus, to state the explanation more explicitly, the conditions most favorable to the widespread appearance of the Army Worm in our cultivated fields and meadows are one or more dry seasons that will permit it to multiply in swampy places that are ordinarily overflowed, followed by a wet Spring in which the rains are not copious enough to overflow such places until the bulk of the moths have issued, and which soon afterwards are copious enough to overflow the low lands and oblige the moths—both those issuing in the Fall and in Spring—to lay their eggs on higher land which they ordinarily would not prefer.

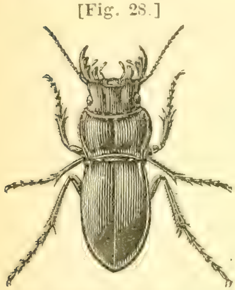
The insect is with us every year and often attracts considerable attention in restricted localities the year preceding its more general advent. I have reared the moths from the worms on three different occasions since the last general appearance of the species in the West in 1869.

In the normal cut-worm-like condition they easily escape the eyes of man; but when the bulk of them have passed through the last molt, or, in other words, are nearly full-grown, and have stripped the fields in which they were born, they are then obliged to migrate in bodies to new pastures. Thus assembled and exposed, they pass through grass and grain-fields, devouring as they go; for they are now exceedingly voracious, and, like most Lepidopterous larvæ, consume more during the last few days of worm-life than during all the rest of their existence. The farmer who is unfamiliar with their life-habits wonders where they come from so suddenly, and presently, when they enter the earth to transform, he wonders again where they go to. In these exposed numbers, also, the numerous natural enemies of the worms congregate about them and do their murderous work far more effectively than when they have to seek individuals hidden here and there in rank grass; so that we cease to wonder at the almost total annihilation of the species the year following its advent in such numbers. Moreover, while a certain amount of moisture is most congenial to them, excessive rains and storms such as we had last summer, and such as are likely to occur after excessively dry years, must inevitably destroy large numbers—floating many away into rivers, and causing others to rot on and in the ground. Man, too, in his warfare with them on such occasions, destroys great quantities; and, finally, only the vast armies on our cultivated lands disappear so suddenly, numbers remain unobserved in unfrequented and uncultivated grass land.

NATURAL ENEMIES.

"Hogs, chickens and turkeys revel in the juicy carcasses of the worms, and sometimes to such an extent that, as I am informed by Mr. T. R. Allen, of Allenton, the former occasionally die in consequence, and the latter have been known to lay eggs in which the parts naturally white, would be green when cooked. Small birds, of various kinds,* and toads and frogs also, come in for their share of this dainty food; while the worms, when hard pushed, will even devour each other."

[Fig. 28.]



Pasimachus elongatus.

[Fig. 29.]

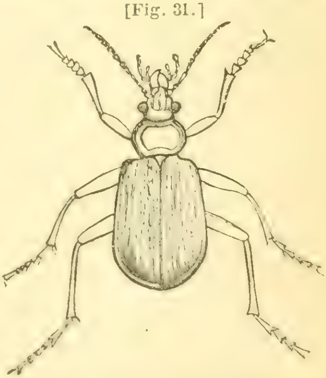
Harpalus caliginosus.

A large number of predaceous beetles gather around and about the travelling hordes and greedily prey upon them. Ten different species have been detected by myself and others in this work,† some of the principal of which are herewith illustrated. The worms have also an unusual number of true parasites. They never abound or travel from one field to another, but they are accompanied by a

[Fig. 30.]

Calosoma calidum, with larva.

[Fig. 31.]



Calosoma scrutator.

* The Rice Bunting (*Doliconyx orizivora*) more particularly has been observed to feed upon them.

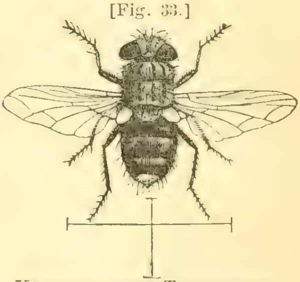
† *Cicindela repanda* Dej., *Elaphrus ruscarius* Say, *Calosoma externum* Say, *C. Scrutator* (Fabr.), *C. calidum* (Fabr.), *C. Wilcoxi* Lec., *Pasimachus elongatus* Lec., *Amara augustata* Say, *Harpalus caliginosus* (Fabr.), *H. pennsylvanicus* (Deg.)

number of two-winged flies which are often so numerous that their buzzing reminds one of that of a swarm of bees. The Red-tailed Tachina-fly (*Exorista leucaniæ*, Kirk, Fig. 32) and the Yellow-tailed Tachina fly (*E. flavicauda* Riley, Fig. 33) are known to infest it. Seizing the first opportunity to attach their eggs behind the heads of the army-worms, these flies are as persistent in their work of destruction as the worms are restless under attack. No worm carries these eggs into the ground with it but falls a victim to the maggots hatching therefrom, and which in a very short time become flies like the parent.

[Fig. 32.]

ARMY WORM TACHINA-FLY.

[Fig. 33.]

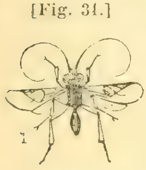


YELLOW-TAILED TACHINA-FLY.

Fully eighty per cent. of the worms which I noticed last year had been attacked by these Tachina flies, which though rendering most efficient service to the farmer, are not unfrequently supposed by him to be the parent and the cause of the worms.*

The next most common parasite of the Army-worm is the Military Microgaster (*Microgaster militaris* Walsh, Fig. 34), a little black clear-wing fly with rufous legs. The larvæ of this fly infest the worm in great numbers, and so enfeeble it that it cannot enter the ground, but lingers—sluggish and paralyzed—on some grass or grain stalk. Presently the little parasites all issue from its body and spin in concert a large amount of cottony silk, in which each individual forms a neat little egg-like cocoon. These are often mistaken by those unread in Nature's mysteries for Army Worm eggs. No greater mistake could be made. This little friend is in its turn preyed upon by a secondary parasite (*Glyphe veridascens* Walsh) belonging to the Chalcid Family.

[Fig. 34.]



MILITARY MICROGASTER.

[Fig. 35.]

GLASSY MESOCHORUS.

The Glassy Mesochorus (*Mesochorus vitreus* Walsh), is another clear-winged fly that attacks the Army Worm. It is but slightly larger than the preceding, and easily distinguished from it by the more graceful form and by a translucent yellowish-white spot in the middle of the abdomen.

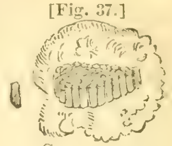
* No less than four of my correspondents have expressed belief that, in the language of one of them, the worms came from "a dark colored, fuzzy fly about the size of a blow-fly, which is noticed around old stack yards just before the worm comes; and when plentiful, the Army Worm is sure to follow."

The Diminished Pezomachus (*Pezomachus minimus* Walsh) is a small wingless parasite which, like the Microgaster, spins cocoons in cottony floss on the back of the worm, but places them close together in symmetrical order. This in its turn is preyed upon by a little Chalcis-fly (*Chalcis albifrons* Walsh.)

[Fig. 36.]

PEZOMACHUS MINIMUS.

[Fig. 37.]

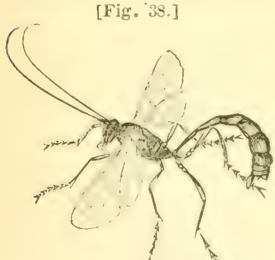


COCOONS OF PEZOMACHUS.

All the small clear-wing parasites, with their secondary parasites, were reared in 1861 by Mr. Walsh, and full descriptions will be found of them in the article of his which I have already cited, and in my Second Report. I reared all of them again last summer, and, in addition, a *Microgaster*, which differs from *militaris* in always having the three basal joints of the abdomen rufous, but which is, perhaps, only a variety. While about 90 per cent of the army worms are often destroyed by the primary parasites, only about 18 per cent of these are destroyed by secondary species.

In addition to these small parasites there are a few larger, Ichneumon-flies that infest the worm. One — the Purged Ophion (*Ophion purgatus* Say, Fig. 38) is a honey-yellow, slender-bodied, waspish insect, with a short ovipositor, the female of which, according to Dr. Packard, attaches her egg, which is bean-shaped, by a pedicel to the skin of the worm; and the footless grub which hatches therefrom, does not entirely leave the egg-shell, but the last joints of the body remain attached thereto, while the larva reaches over and gnaws into the side of the worm. I have bred this same species from various cut-worms, and it spins a tough, brown, silken, oblong-oval cocoon.

[Fig. 38.]



OPHION PURGATUS.

Another species, a true Ichneumon, which may be called the Army Worm Ichneumon-fly (*Ichneumon leucaniæ* Fitch), was reared from the worm by Dr. Fitch; while two other species are figured in Harris's *Injurious Insects* (3rd edition p. 630).

REMEDIES.

In the way of prevention it is a well established fact that burning over a meadow, or prairie, or field of stubble in the Winter or in Spring is an effectual guard against the origin of the worm in such meadow or field. Such burning necessarily destroys those eggs that may be laid in the Fall of the year, and the fact that it is so effectual a preventive has been relied on as evidence that the eggs must be laid in the Fall. Having already shown that there is every reason to believe that a proportion of the eggs (the proportion increasing northward) are laid early in Spring, and that they are laid by preference—if not solely—in or on the mature or last year's stalks, it follows that burning will prove effectual in either event; for a burned field presents no such mature stalks in Spring. Heavy rolling on land that is sufficiently smooth would have a similar beneficial effect, and may also be employed to good advantage to destroy the worms after they have hatched.

As the Army Worm appears in vast numbers during certain years only, and at irregular intervals, and as this appearance is rather sudden and seldom, if ever, anticipated by the farmer, burning as a remedy loses much of its importance, except where it is practiced annually; and in view of the benefit of such burning in destroying chinch bugs and other insects it is to be regretted that the practice of winter burning of fields, prairies, straw-piles, weeds and other litter and rubbish does not more generally prevail: the destruction of injurious insects by such a system would far outweigh the benefit derived from plowing these stalks and weeds under or leaving them to gradually decay.

The worms may be prevented, as a general thing, from passing from one field to another, by judicious ditching. It is important, however, that the ditch should be made so that the side toward the field to be protected be dug under. About every three or four rods a deep hole in the ditch should be made, in which the worms will collect, so that they can be killed by covering them with earth and pressing it down. They may also be destroyed by burning straw over them—the fire not only killing the worms, but rendering the ditch friable and more efficient in preventing their ascent. I have also used coal oil to good advantage, and the worms have a great antipathy to pass a streak of it. Many of my correspondents successfully headed them off by a plowed furrow six or eight inches deep, and kept friable by dragging brush in it. Along the ditch or furrow on the side of the field to be protected, a space of from three to five feet might be thoroughly dusted (when the dew is on) with a mixture of Paris green and plaster, or flour, so that every worm which succeeds in crossing the ditch will be killed by feeding upon plants so treated. This mixture should be in the proportion of one part of pure Paris green to twenty-five or thirty parts of the other materials named. If used in a liquid form, one tablespoonful of Paris green to a bucket of water, kept well stirred, will answer the same purpose. I proved last Spring that this mixture deals death to the worms, but it should only be used where there is no danger of its poisoning other animals. Logs or fences over running streams should be removed; otherwise the worms will cross on them.

Hogs, as already stated, are very fond of them and may often be used to good advantage ; and so may chickens, geese, and other fowls.

SUMMARY.

To summarize from what has preceded, the more important points in the history of the Army Worm, and what we now know of it may be thus stated :

The Army Worm comes from a buff-colored moth having a conspicuous white speck about the middle of each of the front wings. This moth haunts our fields from the middle of June till Winter. Those which issue early in the season probably lay their eggs in Fall, while those which issue later hibernate and lay their eggs in Spring. The eggs are most probably laid on mature grass and grain stalks, whether cut and in stack, or standing. They are either inserted between the stalk and sheath, or attached in rows along the stalk. The worms, when not excessively numerous, hide during the day and are seldom noticed. In years of great abundance they are also generally unnoticed during their early life. The earliest acquire full growth and commence to travel in armies and to devastate our fields and attract attention, about the time that winter wheat is in the milk. They soon afterwards descend into the ground and thus suddenly disappear, to issue again two or three weeks later as moths. The bulk of the worms become moths in this latitude the same season; but a few probably hibernate in the pupa state below ground, and the proportion of these increases as we go north. There is but one generation annually. The worms abound during wet Springs, preceded by one or more very dry years. They are preyed upon by numerous enemies which so effectually check their increase during years of great multiplication, that two great Army Worm years have never followed each other and are not likely to do so. They may be prevented from invading a field by judicious ditching, and burning over a field in Winter or early Spring, effectually prevents their hatching in such field.

THE ROCKY MOUNTAIN LOCUST—*Caloptenus spretus* Thomas.

(Ord. ORTHOPTERA; Fam. ACRIDIDÆ.)

Serious and distressing as were the ravages of this insect in 1874, when the winged swarms overswept several of the Western States, and poured into our western counties in the Fall, the injury and suffering that ensued were as naught, in Missouri, compared to what resulted from the unfledged myriads that hatched out in the Spring of 1875. As nothing in the way of insect ravages had before equaled it in the history of the State, and as the history of this calamity, so fraught with valuable experience and instruction, will form an important record for future reference, if condensed and brought together in an accessible work, I shall devote a large part of the present Report to this insect plague—supplementing the article published in the Report for 1874, by the experience and observation of 1875. It was almost universally admitted by our farmers that, grave as was the affliction, they could have overcome it without great difficulty, if they had had, at the beginning, the experience they had gained by the end of the visitation; and it is my hope that in the event of another such occurrence, the experience here recorded may be made available.

PREVIOUS EXPERIENCE IN THE SPRING OF 1867.

During my travels in the middle western counties of Pettis, Johnson, Lafayette, Jackson and Cass, in which the injury was perhaps the greatest, few things struck me as more remarkable than the little that was remembered by the inhabitants of the previous visitation in the Spring of 1867. Occasionally I would meet with a man who recollected quite distinctly the doings of the young locusts in that year, and such an one profited to great advantage by that experience; but what with new comers since 1867, and want of records, the large proportion whom I met with knew little about it. Another important reason why the farmers were ill prepared for the desolation of last Spring is found in the fact that the previous injury of 1867, from one cause and another, was by no means as wide-spread and severe—the insects did not so generally hatch in such immense numbers; they were more generally attacked by enemies, especially black birds, and the people were in much better material condition to withstand them, and sustain the temporary injury. It will be interesting here to reproduce what was published in my last Report as to the injury that might be expected in the Spring of 1875. The predications were based not only on the general habits and ways of the young insects, but on the experience of 1867, as far as it could be learned:

Setting aside possible but not probable injury from a new invasion, we may consider the probable injury that will result in 1875, from the progeny of those which came in 1874. The eggs which are deposited on southerly hill-sides often hatch before cold weather sets in, if the Fall be warm and protracted, while many hatch soon after the frost is out of the ground in the Spring. Yet the great bulk of them will not hatch till into April. That most of the eggs will hatch may be taken for granted unless we have very abnormal climatic conditions, and unprecedentedly wet and cold weather following a mild and thawing spell. The young issuing from these eggs will, also, in all probability, do much damage, as they did in the Spring and Summer of 1867. But the actual damage cannot be foretold, as so much depends on circumstances. In 1867, in many counties of Kansas and Missouri, where the ground had been filled with eggs the previous Fall, little harm was done in the Spring—so small a percentage of the eggs came to anything and so unmercifully were the young destroyed by natural enemies. A severe frost kills the young after they have hatched, where a moderate frost does not affect them. In Missouri, if we have no weather that prove fatal to either eggs or young, considerable damage may be expected, but not as much as in the country to the West; for, as already stated, we received the more scattering remains of the vast army, and the eggs are neither as numerous, nor will they hatch as early in our territory as farther West. Following a rather mild February the March of '67 was a very severe one, the thermometer frequently indicating 18 degrees below zero, and, according to Mr. W. F. Goble, of Pleasant Ridge, Kansas, who wrote an excellent account of the insect,* this severe weather caused many of the eggs to perish; and he expresses the opinion that "judging from the voraciousness of those that did appear, I doubt not Kansas would have been made a perfect desert if all had lived."

If after the young hoppers hatch we have much cold wet weather, great numbers of them will congregate in sheltered places and perish before doing serious harm; but if, on the contrary, our Spring and early Summer prove dry and hot (which is hardly to be expected after the several dry seasons lately experienced) much damage will result from these young locusts, where no effort is made to prevent it. They will ruin most garden truck, do much injury to grain, and affect plants very much in the order previously indicated under the head of "Food-plants." They will become more and more injurious as they get older, until, in about two months from the time of hatching, or about the middle of June, they will begin to acquire wings, become restless, and in all probability leave the locality where they were born, either wending their way further South or returning in the direction whence their parents came the previous year. Some bevies may even pass to the eastward of the limit line reached in 1874, and fall upon some of the counties bordering that line; but they will lay no eggs, and will, in time, run their course and perish from debility, disease and parasites. In 1876 the Rocky Mountain Locust will scarcely be heard of within our borders; a few remnants from Kansas or Nebraska, or from the country to the southwest, may make their presence manifest, if the year should be exceptionally favorable to their development; but, whether delayed till 1876, or even till 1877, the last one will eventually vanish from Missouri soil, and their race will no more be known among us till—perhaps within the next six or eight years; perhaps not within the next twenty—a fresh swarm wings its way to our borders from the plains along the mountain regions. There is, therefore, no danger of their overrunning the State to the east of the limit line; nor of their doing permanent injury in the counties they now occupy.—[7th Report, pp. 166–7.

How closely subsequent events verified these predications, the following pages and the experience of 1875, so fresh in the minds of our people, attest. Yet the fearful devastation that actually followed was scarcely anticipated, and the conclusion there drawn that the eggs in our western counties invaded were less numerous than in the country further west proved incorrect, for the insects were fully as numerous within our borders as they were across the line in the eastern part of Kansas.

The territory which received the last remnants of the vast army, and in which, from the more scattered numbers and greater debility of the insects, fewer eggs were laid, was less extensive than I had calculated, and as will be seen from the chapters where I more particularly

*Monthly Reports, Dep. Agr. 1867, p. 290.

treat of Missouri, was confined to those counties along the extreme eastern limit of the 1874 invasion, and more particularly to the southwest counties.

I think that the greater numbers in 1875 as compared to 1867 were more owing to the characters of the two seasons than to any disproportion in the number of the eggs laid. The Winter of 1874–5, though commencing late, was severe, steady and protracted till toward the first of May, when Spring suddenly came upon us in full force. There was no very variable weather in the earlier months; whereas such weather did occur in 1867, and the insects not only hatched earlier and were exposed to enemies and adverse influences for a longer time before they could begin to thrive, but they were also more seriously affected by the sudden changes—a steady Winter, however severe, being more favorable to almost all insects than an open and changeable one.

Although the insects came nearly a month later in 1866 than in 1874, and left two or three weeks later in 1867 than in 1875, yet good crops were subsequently grown in 1867; and to show how history repeats itself, I reproduce here extracts from the Kansas City *Journal of Commerce*, for June and July, 1867. The exodus was made during the last week of June, and, as last year, in a N.W. direction.

June 6. "These 'winged beasts' are growing and multiplying amazingly, and their appetite is inordinate."

June 7. "A farmer near Platte river informs us that a morning or two ago he went out to plow his corn, which was about four inches high the day before, and found it all gone."

June 9. "Grasshoppers alarmingly thick at Westport."

June 13. "There seems to be a difference of opinion among farmers. Some say the grasshoppers are destroying everything, and others declare they have touched none of the growing crops."

June 19. "Grasshoppers have opened out on the onion crop in Atchison county, Kansas."

June 22. "The Lawrence *Journal* mentions that a number of gentlemen had carefully watched one swarm of grasshoppers, and they moved south more than two miles in one week. They stopped no longer in grain fields than on bare ground."

Also. "Leavenworth papers report millions of grasshoppers. They have eaten all the smartweed out of Delaware street, and have now commenced on the dog-fennel in some of the main thoroughfares of that prosperous town."

June 25. A reporter visited the place of Major Hudson, on the Shawnee road, the same now owned and occupied by Dr. Thorne, and says: "Grasshoppers are now paying him a visit, and it is taking nearly all he can raise to entertain them. They are making a heavy raid on the gardens and grainfields in this locality."

June 26. "The grasshoppers in this neighborhood do not confine themselves to hopping, but now wing it, and are more animated than ever. Their appetites grow with their stomachs, and their ravages keep pace with both. They appear to be departing, shaping their course eastwardly."

June 28. "We understand that around Westport and Independence the grasshoppers are still doing a great deal of damage. In this locality they are thinning out a little."

June 29. "The grasshoppers are migrating to the northwest by the million. They fly at a great height and are as thick as snow-flakes. It is a goodly sight to see their departure."

Also. "In St. Joseph the grasshoppers are reported as the sands of the sea, and sweeping everything before them."

July 2. "Grasshoppers continue to spread themselves considerably in this locality, but they are not so thick as they were and are evidently migrating."

July 10. "Grasshoppers are all gone from Fort Scott. * * The Kansas City markets are abundantly supplied with garden truck, and cheap."

GENERAL OUTLOOK IN THE SPRING OF 1875.

The Spring of 1875 brought the farmers of the locust region to a crisis somewhat unusual and peculiar. Two previous years of drouth and chinch bugs, followed by the locust incursion of the previous Fall, had armed the people with unusual energy, born of hope and necessity, and there was everywhere determination to put forth the very best efforts. The opening of the Spring favored the execution of this purpose. Timely rains and bright weather crowned the seeding time with unusual hope, and a much larger acreage of all Spring crops was planted. The experience of previous locust years had been generally forgotton, and no effort to destroy the eggs had been made. The same genial sun that made wheat, oats, corn and flax grow apace, brought into activity myriads of the dreaded destroyers. Scarcely had the farmer begun to rejoice over a prospect of uncommon promise, when he saw his fields invaded by an enemy that overcame his utmost resistance. The severely stricken region, covering an area variously estimated at from 200 to 270 miles from East to West, and from 250 to 350 miles from North to South, and embracing portions of Nebraska, Kansas and Missouri, presented a variety of experience, some portions being comparatively exempt from injury, while others wore an aspect of devastation that changed the verdure of Spring into the barrenness of Winter.

The tract in which the injury done by the destructive enemy was worst, was confined to the two western tiers of Counties in Missouri, and the four tiers of Counties in Kansas, bounded by the Missouri river on the East. The greatest damage extended over a strip 25 miles each side of the Missouri river, from Omaha to Kansas City, and then extending South to the Southwestern limit of Missouri. About three quarters of a million of people were to a greater or less extent made sufferers. The experience of different localities was not equal or uniform. Contiguous farms sometimes presented the contrast of abundance and utter want, according to the caprices of the invaders or according as they hatched in localities favorable to the laying of the eggs. This fact gave rise to contradictory reports, each particular locality generalizing from its own experience. The fact is, however, that over the region described there was a very general devastation, involving the destruction of three fourths of all field and garden crops.

For the relief of the sufferers there came the frequent and growing rains, carrying Spring far into the usually droughty Summer, and giving the subsequent planting an admirable start. Then when the pests had increased to their highest number, and were working the most extensive ruin, the flood gates of the clouds were opened, and for thirty-six hours an unceasing torrent swept large numbers of the pests into the streams until the surface of most running water was black with locusts. For the destitution of Kansas an extra session of the Legislature provided partial relief. In both Kansas and Missouri, wherever the scourge extended, seeds were to some extent distributed by the Department of Agriculture, and by enterprising seedsmen, and committees were sent to more favored regions to obtain contributions of money, provisions and seed. In order to convey a more exact idea of the condition of things that prevailed, and of the injuries of the insect, outside of the more severely visited region, I will give a review by States, and in the case of Missouri by counties also.

THE OUTLOOK IN MISSOURI.

Early in May the reports from the locust district of the State were very conflicting: the insects were confined to within short radii of their hatching grounds. The season was propitious, and where the insects did not occur, everything promised well. As the month drew more and more to a close, the insects extended the area of destruction and the alarm became general. By the end of the month the non-timbered portions of the middle western counties were as bare as in winter. Here and there patches of *Amarantus Blitum* and a few jagged stalks of Milkweed (*Asclepias*) served to relieve the monotony. An occasional oat field, or low piece of prairie would also remain green; but with these exceptions one might travel for days by buggy and find everything eaten off, even to the under-brush in the woods. The suffering was great and the people were well-nigh disheartened. Cattle and stock of all kinds, except hogs and poultry, were driven away to more favored counties, and relief committees were organized. Many families left the State under the influence of the temporary panic and the unnecessary forbodings and exaggerated statements of pessimists. Chronic loafers and idlers even made some trouble and threatened to seize the goods and property of the well to do. Relief work was, however, carried on energetically, and with few exceptions no violence occurred. Early in June the insects began to leave; the farmers began replanting with a will. As the month advanced, the prospects brightened, and by the Fourth of July the whole country presented a green and thrifty appearance again. The greatest damage occurred in the counties bordering the Missouri river to Liberty, and thence southward; and Bates, Buchanan, Barton, Clay, Cass, Clinton, Henry, Jackson, Johnson, Lafayette, Platte, St. Clair and Vernon suffered most. The other counties in the district invaded in 1874, and especially those along the eastern border of that district, as indicated in my map of last year, suffered less. In some of these, as in the extreme northwest counties, the reason may be found in the fact that the winged insects of 1874 did not stay long enough to lay excessive numbers of eggs; while in those along the eastern border, the reason is to be found in the fact that, as I stated last year, the winged swarms, when they reached this limit, were weakened and decimated: they were the straggling remains of the vast army. But in order to more correctly state the condition, it will be best to particularize by counties, in doing which, I shall endeavor to record the facts as far as possible in the words of residents themselves.

Atchison County.—The extreme northwest corner of the State, bordered on the west by the Missouri river, with rich rolling prairie, interspersed with timber along the streams, and extensive bottom land—this county suffered severely. Mr. R. Bottom, of Rockport, made the following report about the middle of May:

> The locusts are taking every green thing as fast as it appears above the ground in this part of the county, say ten or twelve miles from the river. Beyond that I am told there is little small grain, vegetables and corn. Most of the county shows as little sign of vegetation as it did in March, except the trees. All small fruit is gone, they have even eaten the weeds. We are rebreaking our land to sow millet and Hungarian grass and plant corn for fodder, after they leave. If we can't raise something in this way this section will be destitute of anything to eat for man or beast. The question is, what shall we do? But few men have money enough to buy corn to do them until they raise another crop. I fully believe if we had commenced in time we could have saved our crops by killing them. I tried my best to convince the farmers in my neighborhood but could only get a few into it. I am sure I have killed more than was hatched on my farm. My plan is to dig deep ditches along the fence in their run with a deep hole at each end of the ditch, into which they pile up and kill each other or smother to death. Holes bored with a post augur is a very good plan. In order to collect them in the ditch I took forty yards of domestic, cut in the middle, made two wings like a partridge net, tacking to stakes every ten feet. Start at one end and stake down at each corner of the ditch slanting inwards, fit down well to the ground so they can't crawl under, this conducts them to the ditch; get ahead of them when they start to travel. I have tried many plans but this is the best. Coal oil will kill them; a shallow ditch will do with water in it, and a pint of coal oil poured in when the ground will hold water.

No general measures of relief were adopted, so far as I have been able to learn.

Andrew County.—This county, though in the heart of the infested region, suffered comparatively little. Mr. J. H. Smith, of Whitesville, places the damage at 50 per cent. of all crops, and Mr. Jno. White, of Flag Springs, writes me that of the first planting not one acre in a hundred was left in most sections. "All the oats, Spring wheat and most of Fall wheat, potatoes, vegetable of all kinds, were eaten down; but with nerve the people went to work and had plenty in the Fall, though a million dollars would not make up the injury."

BENTON COUNTY.—The damage in a few localities was great, but Mr. J. H. Lay, of Warsaw, writes that taking the county as a whole it was very slight.

BARTON COUNTY.—The general destruction and consequent distress were not so great here as in counties further north. Winter wheat and rye turned out well, but of oats and Spring wheat fully one-fourth of the crop was destroyed by the locusts.

W. B. Krimminger, of Leroy, wrote, May 21:

> Grasshoppers have been hatching here for about seven weeks in this locality (township 33, range 32 west) but have not done much damage except to cut out some gardens.
>
> The only effect Fall plowing had on grasshopper eggs was to cause them to hatch out later; perhaps the result would have been different if our winter had been wet instead of extremely dry.

The insects were leaving in a north and north-west direction every favorable day throughout most of June, and by the end of that month farmers were jubilant over the brightened prospects.

BATES COUNTY.—Lying near the centre of the region where the eggs were most thickly laid, this county suffered severely. The people were in a condition that outsi le help was imperative to save many families from actual starvation. For miles and miles every green thing that grew out of or upon the ground had been literally devoured. Committees were sent to Kansas City and St. Louis asking for help, and brought back cheering words and timely aid to the hungry and despairing at home.

Jno. B. Durand, of Prairie City, wrote me, May 17:

> The locusts are of more notoriety here at present than anything else. It is actually alarming and distressing to see all our crops and pastures eaten off until they are as bare as in midwinter. They take everything green, even tobacco. They keep the leaves off of some of my apple trees so that I am afraid they will die.

A prominent merchant of Butler, wrote, May 19, to the *St. Louis Globe-Democrat:*

> We are having terrible times in this county now. The grasshoppers have destroyed the country; there is scarcely a green shrub in the country. All of our crops are destroyed, and there is no prospect of the hoppers leaving. Our town is being threatened with a raid by the starving people from the country.
>
> Our condition is awful, and God only knows where it will all end.

The merchants and citizens of that town and vicinity held several meetings, and raised enough money to purchase a car load of seed corn. This was distributed to responsible farmers *for seed only.* Other arrangements were made to supply the immediate wants of the people and Messrs. Devinney, Hannah and Childs were appointed a committee to distribute the corn.

By the end of May the condition began to change for the better, and by the middle of July everything looked promising. There was just rain enough to make the corn grow rapidly. But little wheat had been sown; oats produced a fair crop; flax yielded about one-quarter of a crop. A large amount of castor beans was planted, and the crop was excellent.

BUCHANAN COUNTY.—By the end of May the reports from this county were various and the opinions of farmers differed widely. The insects were in spots. Some farms had not been touched at all, while others had been stripped of every green thing. They impeded the progress of the trains on the railroads, and in some places created a most disagreeable stench. In most parts of the county so completely did the locusts do their work, that, had it not been for the foliage borne by the loftier timber, the general aspect of nearly all parts of the county would have been that of Winter.

The following letter, written June 7, by J. S. Talbot, of Easton, to the Hon. Waller Young, and read before the State Board of Equalization, then in session, conveys, perhaps, the most correct idea of affairs:

In answer to your inquiry, I would say that our prospects are gloomy indeed. I think by the time the hoppers leave here they will have devoured everything green. The crops are about all destroyed now, together with meadows and pastures. The country would present the appearance of winter if it were not for the foliage of the timber. The leaves are all stripped off the hazel bushes. I think they will live on us yet some three weeks. If they stay this length of time God only knows what will be the result with this people. The farmers are generally in good spirits. Some are planting, others are going to commence in eight or ten days, hoping the 'hoppers will leave by the time the corn comes up. The outlook is a dark one. There are but few who have the seed, fewer who have anything to support teams necessary to raise crops. Do all you can to reduce the burdens of the tax-paying farmers. Many of them have not paid last year's taxes, and what is to be done in the premises I am unable to say. It seems to me there ought to be a called session of the Legislature and some relief afforded in the shape of stay-laws as to taxes and debts. So far the people seem very indulgent as to debtors. There is but little money here. My crops are all gone—fifty acres of corn, the same amount of wheat, twenty acres of oats and fifty acres of meadow. The most of the meadows are killed outright. Much of the stock is being taken north into Gentry, DeKalb and other counties. It would astonish you to see the courage of the farmers, the surroundings considered. They are determined to keep up courage and hope for success; will not beg or ask for outside assistance till the last vestige of hope is gone. If the hoppers will leave in two weeks we can raise plenty to winter on.

The request there made to reduce the taxable valuation of the property of the county was granted, and no further measures for general relief were adopted.

CALDWELL COUNTY.—The injury was confined to the extreme southwest corner of the county. Reports from C. L. Gould, of Hamilton, and D. W. Monroe, of Kidder, show that even here the damage was slight.

CASS COUNTY.—Sustained perhaps the most damage of any of the counties in the afflicted district. The general expression that it was the darkest day ever experienced by the people of the county, does not overstate the true condition of things. From many graphic accounts of the outlook in this county, I select the two following, as according most nearly with my own experience.

In April the locusts commenced hatching out in countless millions, and every day since that time large swarms have come to the surface. As soon as they were able to hop and eat, which seems to be in about thirty minutes after incubation, they commenced their depredations. Since that time, though millions have been destroyed, their capacity for destruction has increased. In spots they cover the ground completely; sometimes bushels of them can be scooped up from the area of a few square feet. These will invade a wheat, oats or flax field, and in a few hours scarcely a vestige of vegetation is to be seen. They climb currant and gooseberry bushes, and in a short time the bushes will be entirely stripped of fruit and foliage. They have invaded almost every garden, meadow, wheat, oats, flax and rye field in the county, and have devoured them. * * * * * * * * *

It would be impossible to give in our brief article an adequate idea of their devastation in Cass county. Mr. Lee Emerick says they took fifteen acres of fine oats for him in three hours. Judge Frank Clark had a fine field of wheat which was entirely destroyed last Sunday afternoon. Numberless instances could be given of fields perfectly beautiful in verdure one morning, presenting an aspect as bare of vegetation by the next day as they were at planting time.—[*Cass County Courier*, May 21, 1875.

Those persons at a distance and out of range of the plague can have but a faint idea of our situation, nor can they comprehend the fearful ravages made by these pests. These have already eaten up the wheat and oats, and are taking the corn that is planted as fast as it appears above the ground. Our gardens and meadows have been totally despoiled, and our once beautiful, flower-decked prairies now look as desolate and barren as the desert. Our stock will either have to be sent off or starve, as there is nothing for them to eat. The influence of the plague (there is no use denying the fact) is being severely felt in our towns and cities by all classes. Business is becoming stagnated, work of all kinds is on the decline, and gloom and despondency fill almost every heart at the prospect of famine and possible starvation, which must surely come unless assistance comes from some source.—[*Pleasant Hill Review*, May 25, 1875.

Mr. W. H. Barrett, a prominent merchant of Harrisonville, wrote me, May 27:

In reply to your enquiries about destruction of crops, I will say, of my own personal knowledge, as follows: I had loaned flax seed enough to sow an acreage of ten thousand acres, and now there is not one acre left standing in the county. I have some five thousand acres of castor beans out and I find that they are not damaged to any great extent, and this is the only exception of any crop I know of in the county. Flax, oats, wheat, early corn, and in fact every green vegetable is destroyed, and they are now working on the fruit of all kinds, and I find all of this year's growth of young trees is being eaten off and great apprehension is felt for fear they will kill the trees. In fact, all the small fruits are eaten bare, and in my opinion, are now killed.

Even the forest trees did not escape the destroyer. The castor bean, which the locusts at first refused, was finally to some extent eaten. Large fields were swept away with marvelous rapidity. One farmer testifies that he had one hundred and sixty acres of wheat, rye, oats and corn in fine condition, and that thirty-six hours after his fields were attacked, not a hat full of grain was left.

The almost entire loss of crops of the year previous by drouth and chinch bug, left the people in a sad condition to encounter the misfortunes of 1875. More or less distress settled upon all classes of people, and meetings were held in the different townships of the county for the purpose of ascertaining the extent of the damage done, and to devise measures of relief from the scarcity of food for man and beast, and from the want of seed for a new planting. A county convention was held at Harrisonville, May 18, 1875, to receive reports from the various townships in regard to the destruction of crops by the insects. A large number of the citizens of the county were present. Col. H. M. Bledsoe was called to the chair and J. F. Potts was appointed secretary. A call of the townships disclosed the fact that a large number of persons were destitute, and that immediate action must be taken to escape actual starvation. It was found that the county court was powerless to extend aid on account of the express limitation of the statute. A resolution was passed requesting the Governor to call a special session of the Legislature to take into consideration the state of things and administer relief.

It was also resolved to hold township meetings on the 22d of May, and another county convention in Harrisonville on the 24th of the same month. This subsequent convention was held, reports received from the townships, and the county court requested to appoint a committee of four to proceed to St. Louis and solicit aid.

I twice visited this county and was kindly received by Dr. T. Beattie, Judge H. Glenn, W. H. Barrett, Dr. Abraham, G. M. Houston, Wm. H. Allen, and the Editor of the *Courier*. Visiting the adjacent woods and fields I found that the accounts of the destruction had not been overstated. Being called upon to address the citizens at the court house at Harrisonville, I set forth the history, origin and habits of this locust, stating when the insects would leave, the direction they would most likely take, and endeavored to encourage the people by the assurance that the distress then afflicting them was but temporary and would be followed by abundance.*

As part of the history of the locust troubles in Cass county, and in illustration of the change that three months wrought, I take the liberty of reproducing the following from a report made by the Kansas City *Times* of an address I was called upon to deliver in the same hall, the latter part of September, and in which I endeavored to bring together the dear bought lessons of the year:

Gentlemen—Farmers of Cass County: I left you, hardly more than three months since, with long faces, discouraged, forlorn. You were in despair and almost heart-broken over the gloomy prospects. Desolation and distress surrounded you on every

*With what result, the following extract from a letter from Mr. Geo. M. Houston of that place, will indicate: "Your talk here to our farmers and citizens has had an excellent effect. Every person appears to be in a more hopeful mood. Farmers are talking about following out your advice in planting corn, etc., immediately."

hand, and there was enough to make you discouraged. I told you that the people of the State were, as a whole, blessed with a plenty, and prosperous, and that they would not see you suffer The noble generosity of our more fortunate citizens to the east, and especially of the people of St. Louis, in relieving your more pressing wants at the time, have since justified my good opinion ot our people. At the same time I gave you a full account of the habits and ways of the locust plague, and endeavored to imbue you with confidence and hope by showing that your then distress was temporary, that the plague would leave you at a certain time, and that you would yet be blessed with abundant harvests. I told you that I was imperatively called away to Europe, and should be absent from the country during most of the summer, but that, though I left you in distress, I expected to come back and find you growing the largest crops of most kinds. Surrounded with such gloomy prospects, it was difficult for you to take such a bright view of the future, and while many of you were encouraged and had full faith in my predictions, some of you no doubt went away as doubters. Nor could I wonder at the doubters, because, in spite of the fact that an account of the insect was given in my last official report, and that I had given substantial reasons why the pest would not extend farther east, and would not remain with you, some of our influential journals were not only filled with ridiculous ideas as to the insect's natural history, written by correspondents unfamiliar with the first principles of entomology, but they persisted in spreading the idea that the western counties were to permanently suffer from the scourge, and that it was going to overrun the State and other States to the east—thus unnecessarily increasing the panic, injuring the credit of these counties, and causing many to leave who would otherwise have stayed.

I come back among you to find all my predictions verified, and I joy with you in the bounteous corn crop which I see on all hands, the rich vegetable harvest, and the excellent condition of your pastures and stock. From the first I have placed myself on record, and to do so, it required that faith and confidence born of full consciousness of the fact that my opinions were based on scientific data. It is no slight matter for a public officer to thus risk his reputation, and were you now suffering as you did last Spring, or had my predictions not been so fully verified, your State Entomologist would no doubt be condemned in words by no means measured.

Clay County.—Here again the insects were very bad and trains on the Cameron Branch of the Hannibal and St. Joseph Railroad were often reported as stopped by them. The injury was, however, not general. Many parts of the county were bared, but in the larger portion the wheat and corn were not seriously affected, and by the end of June the insects were flying north in multitudes. Corn was being everywhere replanted and the ground extensively prepared for Hungarian and millet. The following correspondence of the St. Joseph *Weekly Herald* shows the condition of things about the end of May:

Liberty, May 28, 1875.—The grasshoppers in Clay county are doing great damage to the garden and present growing crops. In Liberty, the citizens fought bravely in hopes of keeping them out of their gardens. This week they surrendered. Mr. Hopper has the field. In the county they have ruined several crops, but some still not damaged. Everything green seems to be their preferred dish.

The feed for work stock is entirely exhausted, and the last hope the farmers had to put in their second crop was for their stock to subsist on grass, which last hope is disappearing fast. Several are driving their stock north to graze. Report says our neighbors are objecting, saying they must have what grass is left for themselves.

The hoppers are also doing great damage to the fruit in many places. But our farmers have the Jackson kind of nerve and are determined to pick their flint and try it again.

Kearney, May 28, 1875.—The prospect at present is rather gloomy. The gardens are nearly all destroyed. Oats, clover, and in fact all small grain have suffered considerably from the ravages of the grasshopper, and from a number of farmers we hear that their corn is going too. The recent heavy rains have livened up everything wonderfully, and there is still a prospect for an abundant corn crop, if the pests do not injure it any more than they have done. The citizens of this (Kearney) township wil hold a mass meeting next Tuesday, the 1st, to consider the best means of meeting the coming emergency and to mutually aid and assist each other.

Clinton County.—Accounts gathered from this county are somewhat meagre. The St. Joseph *Weekly Herald*, May 21, contains the following item from Cameron:

There are still no indications of the grasshopper plague in this vicinity, though they have done some damage in and about Perrin, some eight miles southwest of here, on the line of the railroad. So far none have been discovered north, east or south of us, only west and southwest. At Plattsburg, twenty miles southwest, they are to be found in countless millions, and have done great injury to wheat and corn. The farmers in the devastated sections are replanting corn, and the prevailing sentiment seems to be more hopeful than at last report.

At a later date, June 14, Capt. M. S. Payne writes:

As regards the ravages of the locusts, they are fearful, although the air is filled with vast swarms of them like so many bees that had escaped from a hive on their way to other lands, yet enough remains to destroy all vegetation as fast as it comes on, and all prospects for a crop, and sustenance for the coming Winter, unless they leave in the next ten days. The two previous years of drouth in northwest Missouri, together with the enormous financial pressure and heavy taxation have left the people without resource against the fearful invasions of these devouring insects.

They came out of a hard, cold Winter, with stock poor and weak. Many good industrious citizens reached the very bottom of their corn cribs long before Spring opened, and the weather was so cold and dry, and vegetation was so exceedingly backward that the locusts got the advantage and have kept it.

All the meadows, both clover and timothy, are absolutely destroyed, and nothing but frequent and heavy rains will save the blue grass. Our meadow of forty acres is as bare and as desolate as if it had been swept by a fire; both pastures are (with the exception of the green trees) as bleak as Winter. There is no grass left on the place but the little slope of blue grass that runs back of the barn, and that is kept very short. Our corn is still standing, although much injured, and we do not know how soon it will be taken, the oats next to it were black with them yesterday.

*   *   *   *   *   *

The devastation is much heavier and more universal on the west and south sides of the county. The hazel and undergrowth are as leafless as in Winter—all the small fruits of every description are destroyed. Those who were depending on their gardens for support are left destitute, and in the northern and eastern portions of the county, where there is any prairie unenclosed, the grass is not much injured, but there are such vast quantities of stock on it that it affords a meagre sustenance.

Those who expected to plow, off the grass, are left without sustenance for their teams while making a crop, even if the hoppers leave in time for them to replant, and they can succeed in procuring the necessary seeds. Many farmers will have to plow with very poor horses through the hottest and most exhausting weather without feed.

*   *   *   *   *   *

Our people are brave and persevering and the majority of them will do all that human labor and human skill can accomplish, if they can get the right kind of seeds. Not corn alone is needed, but potatoes, navy beans, Michigan peas, buckwheat, millet, Hungarian, turnip seed, and all kinds of late garden seeds. Tomato, sweet potato and cabbage plants could be shipped in, and if we have a late Fall they can be raised for Winter use.

Dade County.—The Dade County *Advocate* of June 3, says: "Farmers report no grasshoppers to amount to anything, and in what few places they have made their appearance they have done no damage as yet. Chinch bugs appear to be leaving most neighborhoods, and not much more damage is anticipated from them. Oats are looking well in most parts of the county."

Mr. R. A. Workman, of Greenfield, writes me: "Those that hatched out in the Spring of '75 were so few and so scattered that they did no harm, and, in fact, were scarcely noticed, and disappeared so quietly that no one knows how or where."

DEKALB COUNTY.—I clip the following from the St. Joseph *Herald* of June 3, from correspondence from Sherman township, May 31:

As assertions prove nothing I will give you the names of some responsible gentlemen who have been injured by the hopper. Capt. S. H. Varner has been run over by them for a week. They have eaten his oats and one hundred and twenty acres of meadow. As yet they have not troubled his corn, but may before night. Mr George Lowe, near Union Star, went to St. Joseph last week and bought him a new cultivator to plow his corn. He returned next day and had not a hill of corn to plow. Adam House went to St. Joseph last Tuesday and returned on Wednesday and found his corn field as bare as the day he planted it. It was six inches or more high. Of course he will plant it over again, but what surety has he that the young hoppers that are now hatching (and they are numerous) will not eat it? Judge Williams, Frank Bowen and numbers of other farmers have been injured by them, while some farms are as yet untouched.

GENTRY COUNTY.—As a whole this county was favored, though in many localities the ground was made as bare as in Winter. Mr. Levi Long, of Island City, writes:

They ate all the wheat that was on high land, also oats and corn; all garden vegetables and a great portion of the fruit. Imagine everything green on the face of the earth eat entirely up; the meadows and blue grass pastures as dry and bare of vegetation as the centre of a State road that is traveled a great deal, and you can probably form some idea of our condition at the time.

HICKORY COUNTY.—The same may be said of this as of the preceding county.

HOLT COUNTY.—In 1867 this county suffered more severely than many others, and I have several correspondents who retain a very vivid recollection of that experience. Last year the county suffered less than many others, and the pests were quite successfully fought. Many crops were saved by ditching, and in one instance a Mr. Walker is reported as saving his crops by ditching around a whole quarter section, on a place called Hackberry Ridge.[—*St. Louis Republican*, July 5.

Since our last these insects have developed their endurance beyond question. They have established a reputation for perfect indifference to storms and cold weather that is truly astounding. They are now going for garden stuff with an avidity that is rather discouraging to the planter. They went for our cabbage patch, and devoured in a few hours, what we had been several months in developing; others have been more unlucky, losing everything, cabbage, peas, raddishes, lettuce, all swept away in a few hours. Some of the farmers in this vicinity have had their wheat, oats, barley, timothy and other crops greatly injured by these pests.

Out on Hickory Creek the hoppers are not so numerous as here, and as a consequence are not doing so much injury; near Craig, Judge Van Wormer reports they are destroying the wheat. Near Forbes they are more numerous than here, and have destroyed about all the gardens; only one piece of wheat is reported as injured yet. Some other parts of the county report none, while others have enough to supply several counties.

All accounts show, however, that we are not as bad off as some of our neighbors. —[*Holt County Sentinel*, May 15.

HENRY COUNTY.—A correspondent of the *St. Louis Republican*, under date May 26, thus describes the devastation in Henry County:

The locusts have already destroyed a large portion of the crops in sections of this county, and still continue their work of devastation. The western and northern part of this county is almost a desert, there being scarcely a vestige of *anything* green remaining to be seen. They don't seem to have any definite direction to travel, but at present they are moving southeast, and, if they continue in that course, the entire crop of this county will be destroyed. The largest are as yet not more than half grown, and will probably not be able to fly for one month or longer, while many are yet hatching. [Subsequent events proved this incorrect: the bulk of them left by the middle of June.] Our farmers are so alarmed that some are leaving their farms, while many would do so but are unable. Grass on the prairies is destroyed in certain localities and people are compelled to drive their stock some distance for grazing. Many farmers have planted their corn the second time, and will plant again if the locusts leave soon, while many have exhausted their means and will be unable to buy seed or provisions, and will actually starve unless they receive immediate relief. These are serious facts, and are entirely free from exaggeration.

A mass meeting of the citizens of the county convened at the court house on May 21st, to devise some plan of relief for the destitute. Dr. J. H. Britts was called to the chair, and Thos. Day elected secretary. A committee consisting of Messrs. McLane, Tewell, Woods, Gantt, and Dr. Salmon was appointed to prepare a plan of action. This committee reported as follows:

Your committee have come to the conclusion that we have not the means in our midst to relieve the necessities of our poor. The great destitution is alarming. We must have aid. We are now in the midst of a famine. The people of Henry county have always contributed liberally when other sections needed our aid; believing then that an appeal to those portions of our country that have been blessed will bring contributions of corn and bacon for our poor, we are in favor of sending duly accredited agents to solicit aid from the people of other portions of the country, and especially the great centers of commerce.

Committees were appointed to visit Illinois and Iowa to solicit aid. They carried the seal of the county court, and were instructed to receive and distribute contributions. The following resolutions, adopted by the meeting, express the intense feeling that pervaded the county:

Whereas, Owing to the fact that there is now great and wide-spread alarm among all classes of citizens of this county at the ravages of the grasshoppers and chinch bugs, and that much harm will necessarily inure to the growing crops of the county, and in many instances the flax crop is already destroyed; Therefore be it

Resolved, 1st, That to prevent the destitution that must necessarily follow if the crops of the county are destroyed, and not replenished, we earnestly recommend that farmers do not cease to plant as long as a crop is likely to mature at all; that after it is too late to plant corn, we recommend that Hungarian and millet be sown for the purpose of supplying the deficiency of the hay crop.

2d, That it is only by earnest and persistent effort that we will be able to supply the loss caused by these pests, and to some extent prevent the calamity that now threatens us.

3rd, That the chair appoint a committee of three to proceed to Jefferson City, and in behalf of the tax-payers of Henry county memorialize the State Board of Equalization now in session, to put the valuation of property in Henry county at its present cash value.

Jackson County.—The devastation in other adjacent counties was repeated in this. Mr. Z. F. Ragan, of Independence, with whom I spent some time during the most critical period, writes:

While young they did but little damage, neither did they excite much alarm, since persons who had resided here, when they were here in 1867, assured us that but little damage might be apprehended, inasmuch as in '67 they only cleaned up the dog-fennel along the public highways and the weeds out of the corn fields. But lo, and behold! When they commenced moving in vast armies, and all kinds of growing crops disappeared before the black dead line of their advance, threatening destitution and even starvation, a general alarm pervaded the whole community, and many that had treated the matter lightly, began to comprehend the situation and saw at once, that notwithstanding they might be themselves self-sustaining, if they were surrounded by destitute and needy people, they could have no security in what they might call their own. Meetings were called in every school district and committees appointed to ascertain the true condition of every family and report to the county committee, which was provided with a contribution fund to provide seed and supplies for all that needed aid till something could be raised for the support of man and beast. With all the crops of wheat, rye, oats, flax, clover, corn, gardens and pastures consumed in defiance of every human effort to stay the general devastation (say up to the 1st of July), the fields being as bare as the public roads; the outlook was gloomy beyond description. Many gave up in despair and left the county.

The following from a correspondent to the St. Louis *Globe-Democrat* of May 28, may be taken as a fair statement of the condition of things:

But now, within a month they have become multiplied millions upon millions, traversing the whole country, spreading themselves in all directions, going to and fro; and I may safely say there is scarcely a square yard in the county which can claim exemption from their ravages. Pastures have been stripped of herbage, oat and wheat fields have been swept, gardens are bare of any growing vegetable, and the cornfields are alike destitute of indications that anything has been planted. The small fruits are irrevocably gone, and the larger fruits are now becoming a prey to their devouring powers. They swarm into the houses, hopping and climbing in every place that is not absolutely closed against them. No one who has not seen them can have a conception of their amazing number. They have been destroyed in all possible ways—by fire, by ditching, and various other modes—in bushels beyond computation, and yet they are the same ubiquitous host. So great is the dearth of anything upon which cattle may feed that they are daily being removed to distant counties and ranges where pasturage can be had. The condition of affairs is indeed gloomy, and much solicitude is felt in regard to the issue. Many are disposed to yield to despondency, but the larger number of our people are still resolute and hopeful. There will, of necessity, be many cases of destitution, but we hope to be able to provide for all such, and not apply for aid from abroad until we have exhausted our own resources. The situation is by no means desperate. An occasional field has been lightly touched, and the corn, which is the real staple of the country, though constantly eaten off as fast as the blade appears, it is thought has sufficient vitality to cause it to grow when the pest disappears, and even if it does not a fair crop may be secured by planting a quickly maturing variety even as late as the 1st of July.

A Farmers' Delegate Convention was held at Independence on the 26th of May, and was largely attended, 750 being present. They adopted resolutions reciting the destruction of all crops, fruits, meadows, etc.; that in consequence of the short crops of the two preceding years, farmers had not means to prevent suffering or provide seed for replanting; calling upon the people to meet in the school districts on the next Saturday, to make lists of persons needing aid; calling upon the county court to provide for such persons; appointing a delegation to visit the State Board of Equalization, and ask a reduction of fifty per cent. on the assessment of 1875; appointing a committee to wait on capitalists and banks and negotiate for money to pay for seed and relief; that the people of Jackson county will help each other to the utmost extent, and in case that is not adequate, will call on the Governor to convene the Legislature to provide further relief;

and, finally, appointing a committee to issue an appeal to the people of Jackson county, and discouraging all unlawful acts by sufferers.

An adjourned meeting was held at the same place on the 31st of the month, at which 150 delegates were present. The story of destitution recited that many were living on bread and water; trees were being cut down for food for cattle. A relief committee was appointed and donations were solicited from all who were able and willing to help. As a result of this movement about $5,000 to $7,000 were collected and distributed.

I spent some time in this county, and the gloomy outlook toward the end of May could not well be exaggerated. The stench from the immense numbers that were destroyed around Kansas City, was at one time unendurable, and lest it should breed a pestilence the authorities of Westport took measures to deodorize and disinfect the atmosphere on a large scale. Fifteen barrels of locusts were one evening shoveled up and hauled from the base of the court house at Independence, each barrel weighing 220 pounds. These were only a portion that were unable, after a hard days' battle, to get inside where there was a luxuriant growth of blue grass.

Johnson County.—The western portion of the county was most severely handled. In the vicinage of Kingsville it was estimated that four-fifths of all the wheat, oats, rye, corn, flax, meadow, wild grass and garden products were destroyed. At a meeting of farmers from Madison township held at Holden, June 2d, and presided over by the mayor, Hon. W. C. Smith, it was shown that the locusts had devoured all the wheat, flax, clover and timothy represented, together with half the corn. Potatoes were entirely ruined, and but little fruit, small or large, left. It was found necessary to drive live stock out of the county to localities more favored to prevent starvation. A large number of families were reduced to a bread and water diet. All were hard pressed to raise means for obtaining seed for replanting, and work teams were so reduced as to be scarcely able to perform their necessary tasks.

At the invitation of the county court, a delegate convention was held at Warrensburg on the 28th of April, all the townships in the county being represented. Dr. J. M. Fulkerson was elected chairman, and Rev. I. N. Newman, secretary. A committee of one from each township was selected to propose some plan for meeting the necessities of the county. The matter of relief was finally referred to the action of the individual townships. In some of the townships effort was made to effect large loans upon bonds given by the most responsible men in the community, the object being to sub-loan the amount thus obtained, in smaller sums to those who possessed but little property, and yet sufficient to secure a note for such an amount as would be needful to supply their families and buy seed.

On three occasions, in May and June, I visited the country around Holden and Warrensburg, and publicly addressed the people at the latter place. The better class of citizens were determined and hopeful, and the condition of the county, judged by the payment of taxes, compared favorably with its condition in previous years, for in Warrensburg township $32,000 were collected out of $39,000.

LAFAYETTE COUNTY.—Although lying on the eastern border of the region visited by the locusts, this county shared largely in the general affliction and distress. A correspondent of the Chicago *Times* under date, Lexington, May 18, says: "The grasshoppers are on the move east, eating everything green in their road. One farmer south of this city had fifteen acres of corn eaten by them yesterday in three hours. They mowed it down close to the ground, just as if a mowing machine had cut it. All the tobacco plants in the upper part of the county have been eaten by them." Other advices show that many neighborhoods were rendered destitute, and the want of seed for replanting was widely felt. No public measures of relief were adopted, so far as I have any knowledge, and it is probable that none were necessary.

NODAWAY COUNTY.—In the St. Joseph *Herald* of June 3, there appears a brief item from Graham, Nodaway county, under date May 29th, as follows:

> We have some locusts here, but they are doing no serious damage to crops or gardens in this immediate vicinity. Five miles north of here there are no locusts. South of here, in Andrew county, they are numerous, and in places are destroying crops and gardens. West of here, in Holt county, they are not doing much damage, except in the west part of the county, where they are sweeping everything in places. Farmers are following after and replanting.

This county appears to have been singularly fortunate, a fact which may perhaps be accounted for by the large amount of timbered land in the county, together with its prominent undulations of surface.

NEWTON COUNTY.—Few eggs were laid in this county, and no serious ravages are reported.

PETTIS COUNTY.—Only the western part of this county suffered, and that not severely.

PLATTE COUNTY.—Under date May 25th, a correspondent to the St. Louis *Republican* thus describes the ravages of the insects in this county:

They have destroyed all the gardens in this vicinity, not sparing the onions or peas. The rose-bushes, instead of presenting one solid mass of bloom, look like so many bundles of sticks stuck about in the yards. They are materially injuring the young fruit trees as they climb upon them to roost, and during the night they cut off every green branch. The grapes have been cut the same way. In fact we have but little left. The pastures are full, and our farmers are sending their stock away to hunt grass. Some have felled trees for their stock to browse upon the green boughs. They have destroyed nearly all the corn and have been busy at work in the wheat fields, eating all the blades, leaving only the bare stalks standing. Every evening these stalks are crowded with the little pests, and it is feared they will destroy the bloom of the wheat, as they have nothing left upon which to feed.

Farmers drove away their stock to more favored localities, and for such as they were obliged to retain they cut down linden trees for feed. No concerted measures for relief are reported. The Platte City *Landmark* reports by the 24th of May, that the people had become more or less disheartened, and had about concluded that no effort of theirs could stay the ravages of the pests. Whole fields of wheat, corn, grass and most of the gardens in that county had been swept as clean of every green thing as if a simoon had blasted them. An army of the insects, about one hundred yards wide, attempted to cross Platte River, at Darnall's Ferry. For miles up and down the river the water was a living mass of them. Mr. Darnall at once summoned his whole force of farm hands, consisting of twelve men, who, with the aid of clubs and sticks, kept them from returning to shore, or crossing, until they became exhausted and floated off with the current. Mr. Darnall thinks that at least five hundred bushels were thus destroyed. He thus saved about one hundred acres of as fine wheat as he ever raised.

RAY COUNTY.—A gentleman residing at Richmond writes, May 23:

Since the reception of your note, I have been at some pains to gather the facts you asked for, and I send them in a shape as much condensed as possible. After riding about over the county for two days, and talking to reliable farmers who have been pretty much all over it, the truth learned seems about to be that we have been worse scared than hurt. The grasshoppers are not general over the county. In some places where they are they have eaten considerable, and in other places none at all. Myriads of them are dying. In some places so great is the mortality that the stench is sickening. Our general crop prospects are good. We have had fine rains. So far our grasshoppers seem to get no wings. From the places where they were hatched out to the places where they now are, the distance traveled won't amount to fifty yards. We are all hoping for the best, and believe the worst is over.

The following from the correspondence of the Kansas City *Times* shows the condition of things June 14th, nearly a month later:

The grasshoppers are still here, and doing a great deal of damage. They have left the high lands in places and gone to the bottoms. Thousands of them are daily flying away. A great many of them were seen flying on Sunday, from 11 A. M., to 5 P. M., going in a northwesterly direction. Great numbers of them dropped in Camden, and pounced upon the first green thing that came in their way. Crops continue to suffer; many farmers have turned their stock in on their wheat; oats are going every day, and young corn is badly injured, and in many places entirely destroyed. Farmers are almost despairing of a chance to replant anything. Tobacco plants are all destroyed, as far as heard from. Hemp is badly injured. Fruit trees are suffering from the hoppers, as they are cutting off the young fruit and leaves, even dropping the young twigs to the ground, seemingly, to feed the weaker ones who cannot so readily get up in the trees.

The St. Joseph *Herald*, May 27, reports from Richmond, "that in some localities the locusts have taken the corn and wheat clean, and in other localities there has been little or no damage as yet. Some are planting their gardens and corn over, and think the 'hoppers' will leave the country before they can do damage to the second crop."

The Richmond *Conservator* of May 29, says, editorially:

Our exchanges are filled with accounts of the appearance and depredations of these pests; many of which are exaggerations, especially that report from Richmond, published in the St. Louis *Times* and *Dispatch*. The visitation is bad enough, we want it no worse; but, if accounts are correct, we have but few compared with the numbers in other counties. With but rare exceptions, no one has been seriously injured here.

St. Clair County.—Correspondence of the St. Louis *Republican* of June 3, shows, graphically, how great was the destruction and consequent destitution in the larger part of this county:

At the end of the war not ten buildings remained to mark the place of the once centre of trade. Even the court house was destroyed. The terrible sights of the cruel war are now being outdone by the cruelest of sights—starvation. For the past three years the crops of St. Clair county have been a total, or nearly total failure. Last Fall the pangs of hunger stared many a strong man in the face, but with the assistance of help from the more fortunate he kept it at a safe distance only to return again with redoubled fury. Within the past few weeks cases have come to hand which excel and leave in the shades of night the thrilling scenes of battle and tender feelings generated by the tale of Indian warfare, where the scalping knife plays the most important part. Ten times more preferable would death be under the club of the savage than under the lingering cruel death of starvation. A true statement of events cannot, in fact, be better portrayed than is shown by a circular which is being circulated around the county, calling for a meeting of the citizens to devise some means whereby death can be driven from the door of suffering humanity. The following is a copy:

"Friends, you have been instrumental in relieving the most pressing wants of many of your citizens, and I hope you are still willing to aid them a few weeks longer, until they can be able to help themselves. Through the committee here there have been forty-four families aided. There are of that number now, perhaps one-half, who can get through upon their own resources, and the balance will need help.

"Friends, I appeal to you in behalf of suffering humanity, to do your duty in this case. If you could but see what I have seen, of the destitution of our people, you would not hesitate in this matter, but would gladly help the old and infirm, the crippled, the widows and orphans, whose cries for bread, bread, are ascending up to heaven. Will you respond to their cries? I believe you will. May God help each and every one to do his duty in this matter. I hope the good people of Osceola will call a meeting at once, at which time and place the truth may be made known and the required relief given."

This represents the destitution of but one town out of ten. The picture is unvarnished and put in as mild a form as possible. We have seen within the past week families which had not a meal of victuals in their house; families that had nothing to eat save what their neighbors gave them, and what game could be caught in a trap, since last Fall. In one case a family of six died within six days of each other from the want of food to keep body and soul together. But it is but justice to say that the neighbors and citizens were unaware of the facts of the case and were not, therefore, responsible for the terrible death which overtook these poor pilgrims on their journey to the better land. This is, we believe, the first case of the kind which has transpired in this county; but, from present indications, the future four months will make many graves, marked with a simple piece of wood with the inscription, "Starved to death," painted on it. Our citizens have given, all that had any to give, until nothing is left to give, and now they must in their turn solicit aid from elsewhere. It would be more encouraging if the prospects for a fine harvest were at all flattering, but as the case now is, we do not hope for an excuse for a crop. The grasshoppers have eaten up all the flax, all the wheat and corn, and now are attacking everything green, even grass, and three weeks will witness a country as barren as the grim deserts of Africa. We must have aid from some source or we shall perish. As I write this the sound of prayer and song is wafted on the breeze through the open window from the church across the way, as a crowded house, numbering some six hundred souls, are offering up, in answer to the proclamation of Gov. Hardin, their humble prayers for the interposition of Divine Providence to relieve the calamities which are falling with such fury upon this county. May the Lord, in His mercy, take pity upon this afflicted people and save them from the death which will surely overtake them unless a miracle is performed.

Vernon County.—Hon. William Hall, of Walker, writes, May 20: "We are in the midst of an army of insects. Between the grasshoppers and Chinch bugs this county is threatened with famine both for man and beast." From a correspondent of the St. Louis *Republican*, June 4, it appears that the ravages were chiefly confined to the northwestern portion of the county.

The other counties of Cedar, Dade, Daviess, Harrison, Hickory, Jasper, Lawrence, McDonald, Polk and Worth, that were visited in 1874, suffered comparatively little from the unfledged insects in the following Spring.

CONDITION OF THINGS IN OTHER STATES.

Kansas.—The ravages of the young locusts in this State, during the Spring of 1875, were confined to a district about 150 miles in length and 50 miles in breadth, at the widest, along the eastern border. The counties of Doniphan, Brown, Atchison, Jefferson, Leavenworth, Douglass, Labette, Johnson, Miami, Franklin, Linn, Bates and Bourbon suffered more or less severely. These counties comprised the principal hatching-grounds of the insect, for, although the invading hosts of the previous autumn had been reported as ovipositing in almost every county of the State, time proved that the great bulk of the eggs were laid as the locusts approached their eastward limit. In 1874 the greatest damage had been from northwest to southeast, being lightest along the eastern half of the State which the winged insects reached too late to do very serious injury. In 1875 the tables were turned; the eastern portion of the State suffered, and the western counties were little troubled.

A small proportion of the eggs, which had been deposited in dry, sunny situations, hatched during the autumn of 1874; but there is no evidence that any of the young thus prematurely brought into the world survived the Winter. On the contrary, certain experiments made the following Spring demonstrated the fact that a temperature of 2° below zero was invariably fatal to them.

The insects were reported as hatching in a few localities, and mostly along river bottoms, as early as the middle of March; but it is the general opinion of my correspondents that all such early colonies perished from subsequent cold and freshets.

Prof. Snow, of the State University at Lawrence, records the fact of seeing the first young locusts upon the southern slopes of Mt. Oread on April 6th, and soon learned that a simultaneous hatching had taken place in many spots of bottom land, along roadsides and in fields of grass and grain. From this date until about the 10th of May they were reported from various localities as "still hatching."

Many citizens of the infested district labored with heroic determination to save their crops from the pests, and such efforts measurably succeeded in keeping them in check.

Continued wet weather and hail storms in some localities greatly reduced the numbers of the insects, and a large proportion also perished before acquiring their wings, from the attacks of various parasites.

From all the data accessible it would appear that the locusts first took flight in Kansas from the extreme southeast of the infested region, on May 28th and 29th, and that these swarms passed over the State in a northerly and northwesterly direction. At Ft. Scott they began flying on June 1st. At Lawrence the first winged locusts were observed May 30th and the first flight from that locality occurred on June 3d. At Chetopa they commenced flying June 5th; at Topeka, June 6th; in Worth and Jackson counties June 8th and 9th. By the 13th of the same month they had nearly all taken their departure from Lawrence and the region southward, and by the 15th were gone from as far north as Leavenworth.

The testimony of a vast majority of observers is conclusive as to the general northwesterly direction of their flight. The few cases on record of their moving in other directions are attributable to strong adverse winds or to the fact that they were merely making short aërial excursions preparatory to the grand flight. It was noticed that when they flew to the south or east it was at a much lower elevation than when apparently returning to their native habitat.

The following interesting observations on their flight in Kansas are from an article by Prof. Snow, in Kansas City *Times:*

> The direction of their flight I have carefully noted. When the wind is strong they fly with the wind. If the wind is light they fly toward the northwest, by what seems to be a natural instinct. Thus on June 7th, with a southwest wind moving, according to the University anemometer, at the rate of three miles an hour the locusts were flying in vast numbers in a direction a little to the north of west *nearly in the face of the wind.* On June 12th also, with a northeast wind blowing at the rate of four miles an hour they were flying in greater numbers than ever before in a northwest course *at right angles to the direction of the wind.*

Having once taken wing, there are on record but two or three instances of their alighting within the borders of the State. In these exceptional cases they remained but a short time, and, tho' creating much alarm, did but little damage—being far less voracious than had been the invaders of the previous Autumn.

There were no incursions into the State this year from the north or west, and after the middle of July scarce a specimen of *spretus* could be found in Kansas. The disappointed, but not disheartened, farmers went to work with a will, putting in late crops; the devastated fields and gardens renewed their green under the influence of frequent showers, and by Autumn there were but few mementos of the desolation of the previous Spring.

The amount of damage done to the early crops is difficult to estimate. During the prevalence of the plague it was doubtless considerably exaggerated, for even in the localities where the locusts were most numerous they seldom made a clean sweep of the crops, with the exception of garden vegetables and like succulent plants, for which they manifested a decided preference. In many instances they would completely strip one field, while perhaps the adjoining one would entirely escape.

Leavenworth county reported a loss of about 50 per cent. of the Spring crops; Doniphan lost 30 per cent.; Miami 25 per cent.; Brown 20 per cent., and other counties, where the locust injuries had been confined to certain sections, averaged a loss of from 10 to 15 per cent.

Census returns from sixty-two of the seventy-six counties show the total population to be 494,172. The remaining counties had a population, in 1874, of 41,905. If the returns for this year show an equal number, the population of the State will be over 536,000. Thirty-eight of the counties for which returns have been received show a gain in population, and twenty-three a loss. After such severe trials, this indicates an unusual prosperity; and it is worthy of remark, as illustrative of the enterprise of her people, that the fourth annual Report of the State Board of Agriculture, for the year 1875, is a volume of 754 pages, replete with valuable statistics, profusely illustrated, elegantly published, and edited in a manner that reflects great credit on its Secretary, Mr. Alfred Gray.

The report of the operations of the Kansas State Relief Society was completed during the Summer. It covers all the transactions of the committee in detail, from its organization November 19, 1874, to its disbandonment June 9, 1875. The amount of cash contributions received is given at $73,863.47, and the quantity of supplies at 265 car loads, and 11,049 separate packages. The estimated value of supplies is put at $161,245, which, added to the cash receipts, makes the aggregate benefactions over $235,000. In addition to this, the United States have given nearly $100,000 in rations and clothing, and over $7,000 has been sent directly to the various counties from the east, and is not included in the committee's reported receipts. It is safe to say, counting everything, that fully four hundred and fifty thousand dollars in money and supplies were sent into Kansas since the 20th of November, 1874, for the relief of the locust sufferers. The largest amount of money was contributed by California, and the largest quantity of supplies by Illinois.

The following observations were made at the Signal Service Station at Leavenworth:

On the 6th of June last, the locusts were seen flying for the first time this year. They were flying north. At times, when the wind was due north and brisk, their direction would be apparently west, but a close observation would show that they retained their northerly direction. Large hordes could be seen flying almost every day for two weeks, but as they were flying at a great height, and also owing to the brilliancy of a Summer sun, it was impossible to observe their size and thickness. On the 20th of June, those that were flying north disappeared. On July the 6th and 7th, two large hordes were seen flying southeast; with this single exception, the locusts were flying in a northerly direction in 1875. The locusts of this year flew apparently but a short distance north, and this is supposed to be due to the fact that they were destroyed by a small insect that could be seen in multitudes through a microscope upon the greater number of those that were full grown.

NEBRASKA.—The hatching grounds of the locusts in this State were limited to the district immediately bordering on the Missouri River, and a comparatively small area suffered from their attacks during the period of development. The populous and highly cultivated counties of Nemaha, Richardson and Otoe were most severely ravaged. In these a very large proportion of the Spring crops of all kinds were devoured by the young hoppers, while the attacks of the insects on nursery stock, following those of their progenitors of the previous year, entailed losses which it will take several years to repair. Portions of Adams, Cass, Lancaster, Seward, Josephine, Miller, Saline and Table Rock counties were also put under contribution for the sustenance of home-bred schools; but in these the damage was local, and, with a few exceptions, inconsiderable. From the data at hand it would appear that the insects hatched remarkably late, and it was not until about the 20th of May that their depredations became serious. As in Missouri and Kansas, the farmers energetically defended their crops by means of ditching, burning and coal oil traps. For the latter the insects seemed to have a great affinity, and once thoroughly immersed in the fluid, they were sure to die. Before the armies which had been bred within its borders were fully developed, Nebraska received transient but repeated visits from the migrating swarms of more southerly latitudes, on their way toward the northwest, and with these it was much more difficult to contend than with those still unfledged. Reports of injuries by foreign swarms were received from the counties of Saunders, Washington, Douglass, Buffalo, Pawnee, Clay and Barton. In portions of these, corn and early vegetables were cut off, and wheat and rye bladed to some extent.

The brood which hatched within the State acquired wings and began to rise from the ground about the 7th of June. Their course, as with those from the south and east, was invariably to the northwest, except during the prevalence of strong adverse winds or absolute calms, and in such cases, they commonly alighted to await more favoring gales. By the 6th of July they were reported as about gone from the State.

The following observations were made at Omaha, and communicated by Mr. Myer:

The locusts made their appearance here on the 14th of June, about 10 A.M., and continued passing to the northwest until about 2 P. M., the wind blowing fresh from the south and S.S.E. The tail end of this swarm settled to the north of this city and a few of them returned to the south on the 15th with a north wind. Great numbers of them were destroyed by the hail and rain storm of the 17th.

Mr. Rosewater, editor of the "*Omaha Bee*," made inquiries regarding this swarm and states that it covered a tract of country 80 miles wide; 60 miles west and 20 east of the Missouri river. It went through a tract in Cass county 10 miles wide on the 13th. This was the only swarm worthy of note that was noticed passing here, though others may have passed unobserved: they sometimes move so high that they can only be seen by looking towards the sun.

The following are taken from dispatches to the "*Omaha Bee*," dated June 7, 1875:

McPherson, Lincoln.—A great many on the wing for several days; yesterday a great many going northeast.

Brady Island, Lincoln Co.—A few hatched out, many going northwesterly.

Columbus, Platte Co.—A few passed northwest lately.

Willow Island, Dawson Co. — No damage. Many on the prairie, including those hatched here. The air is full of them, having no particular direction but flying with the wind. None came down.

Kearney, Buffalo Co.—Going northwesterly.

Gibbon, Buffalo Co.—No locusts hatched; passed twice going north.

Kearney Junction, Buffalo Co.—Going northwesterly—large numbers came down May 30th.

Schuyler, Colfax Co.—Now and then a garden visited.

Nebraska City, Oteo Co.—Going southwest lately.

The following are from dispatches to the same journal, dated June 14, 1875:

North Bend, Dodge Co.—No grasshoppers in sight.

Valley, Douglass Co.—Going north since noon—none alighting.

Millard, Douglass Co.—Going north all day.

Silver Creek, Merrick Co.—Going northwest.

Gilmore, Sarpy Co.—Billions going north.

Elkhorn, Douglas Co.—Going north.

Chapman, Merrick Co.—Going north.

Lone Tree, Merrick Co.—Going north for two days.

McPherson, Lincoln Co.—Going northwest.

Gibbon, Buffalo Co.—Going with wind for last two weeks.

Schuyler, Colfax Co.—A few going north.

Grand Island, Hall Co.—Going northwest for the last few days.

In three or four of the counties where the young had most abounded and where migrating swarms had most frequently settled, the loss of crops was estimated at from 25 to 30 per cent., but averaging the State at large it did not, at an outside estimate, amount to 5 per cent., and according to the Omaha *Herald* of July 16th: "The local damages were more than equalized by the additional acreage under cultivation and the increased yield of all products in other parts of the State."

August 10th it was reported from Laramie City that vast clouds of locusts were flying southward; but nothing further was heard of them from any quarter.

Iowa.—Very few locusts hatched during the Spring of '75 within the limits of this State. On the 26th of May they were reported in considerable numbers in a few localities on the southwest boundary.

The first serious incursions from the south were made about the 10th of June, and from that date to about the middle of July, the western counties suffered considerably from the swarms that were almost constantly passing over, many of which alighted and remained from twenty-four to forty-eight hours in a place, making sad havoc in corn fields, gardens and nurseries. Rye, wheat and oats were also damaged to some extent. From the counties of Mills, Tremont and Council Bluffs a loss of 25 per cent. was reported. Near Red Oak they settled in such vast numbers that the railroad trains were stopped by the oiling of the track with their crushed bodies.

Minnesota.—During the Spring of 1875 locusts occurred pretty generally throughout the western part of the State, especially in the region south of the Northern Pacific Railroad. They seem to have been most numerous and destructive in Blue Earth, Le Sueur, Nicollet, Brown, Sibley, Sterns, McLeod and Watonwan counties. In some of these counties generous bounties were offered for the bodies of the young hoppers, and a vigorous warfare was, in consequence, waged upon them by the farming community, in which both sexes and all ages eagerly participated. A letter to the New York *World*, dated June 8th, has the following: "You can form an idea, not only of the energetic way in which the people have gone to work, but also of the magnitude of their task, when I tell you that two thousand bushels have already been paid for in this (Blue Earth) county up to last night, and they only commenced on Friday last." Taking the different counties together more than fifty thousand bushels of locusts were destroyed. By means of these vigorous measures from two-thirds to three-fourths of the crops were saved, while the price paid for the insects doubtless made some amends for what was destroyed.

A dispatch to the *Chicago Tribune*, dated July 13th, states: "The first foreign hoppers appeared on the Sioux City Road, aligbting between Lake Crystal and St. James on Wednesday last." A few days later they were observed at New Ulm, flying southeast, and at noon of the same day struck the line of the road at Madelia, St. James, Fountain Lake, Windom and Heron Lake; covering the track for about 50 miles of its length. They were described as being "uneasy, most of the time in the air, and, except in certain isolated or scattered fields, as doing but little damage."

From such data as can be procured it would seem that there were no invasions into the State from the original breeding grounds of the insect; but that the "foreign" swarms were from the States immediately to the south and west, and were probably deflected from their usual course by adverse winds. The soil and climate of Minnesota being peculiarly congenial to them, they deposited their eggs in prodigious numbers and probably died there. About the middle of August Gov. Davis appointed a commission consisting of J. C. Wise of Mankato, Warren Smith, of Graham Lakes, and Allen Whitman, of St. Paul, to investigate the history of the insect and its incursions; the purpose being to collect the most complete information possible, with a view to organized effort next year for the destruction of all locusts appearing in the State. The following letter from Mr. Wise, chairman of that commission, contains such interesting statements that I reproduce it, notwithstanding the complimentary allusions:

C. V. Riley—Dear Sir: I received copies of the *Rural World*, and as I take the *Prairie Farmer*, am also in possession of your equally valuable articles in the issues of the 11th and 18th. I have read your report, and your observations and descriptions are so very accurate that we shall draw largely upon them in making our report, for which full credit will be given. Indeed, you are so far in advance of anything else that I have seen that I feel that our State, and indeed the whole Northwest, owe you a debt of gratitude for your investigations of this very important subject.

You state correctly that while a few hoppers may hatch this Fall, the great bulk will not hatch until next Spring. We have heard of some hatching this Fall, but in our travels we have seen but very few. It was the same last Fall. A few hatched, and some were deluded by that fact into the belief that most of them would, and we should escape injury. It was a delusion, for in the Spring when they began to appear, we were convinced that scarcely one in a million had hatched in the Fall.

In a recent trip to the region where eggs are now deposited, we found that in counties where eggs were first laid, the hopper is now formed, and with the aid of a glass the eyes and even limbs may be seen. In other localities the eggs are yellow and filled with a watery substance, which induces many to think that they are rotting, but which in fact is that condition incident to and preceding the formation of the insect.

This fact, however, was pretty generally and indeed invariably observed: That the glutinous fluid which matures and forms the coating to the sack has entirely disappeared and the eggs lie unprotected in the earth. We attribute this to the fact that the heavy rains have so moistened the ground as to dissolve that coating. This, we take it, is an unnatural condition, and, if so, there is ground for hope that the unusual dampness of the earth may assist in destroying at least a portion of the eggs. This condition prevails to such an extent that in all our investigations it was difficult to get out a whole sack, for they would break with the ground.

The hoppers that came into this county last year (1874,) came from the southwest. That was their course when they first flew, and when they commenced leaving they continued the same direction, northeasterly. This summer—the fore part of July—when they left us, they flew southwest, going in the direction from whence they had come, and in depositing their eggs have occupied about the same territory they did in 1873, though enlarging their limits. It was observed that nearly all of this year's hoppers had in the bodies a grub or worm such as you describe in your report, and to a greater extent than any previous year, causing them to die in large numbers.

Yours etc, JOHN C. WISE.

Mankato, Minn., Sept. 19, 1875.

The report made by this commission is an excellent digest of the subject, and by being scattered over the State will do much good. It places the amount of damage done in 1875 at two million dollars, and sums up the experience of the year as follows:

The eggs deposited in 1874, in the more northern counties of the State, began to hatch in April, and the young locusts were killed by the continuous cold and wet weather which followed, and damage is reported only in Becker and Todd counties. The eggs are also said to have been freely destroyed by grubs in Becker county. Along the Red river but few eggs were laid, and along the Mississippi they hatched in too widely distributed localities to have any great effect on the general crop.

The chief damage of the year was done by locusts hatched in the counties of McLeod, Sibley, LeSueur, Nicollet, Blue Earth, Brown and Renville. The hatching progressed through May as usual, and in spite of the warfare waged against the locusts, the damage was great throughout all the counties named. The departure began about July first, and by the tenth of the month it became general throughout most of the districts ravaged. A fresh northwest wind would have carried the greater portion of the locusts hatched in Minnesota far beyond the borders of the State, but after struggling awhile against a southwest wind they settled down upon the fields and continued their ravages. During the remainder of the season they inflicted serious damage upon Jackson, Martin, Murray, Cottonwood, Watonwan and Redwood counties, and slighter damage upon Nobles, Rock, Lyon and Lincoln. By the end of August the locusts had mostly disappeared in one way or another, and the earliness of the disappearance has been accounted for by the action of parasites, which infested the locusts abundantly

The following observations were made by the Signal Service operator at Breckenridge:

The locusts were seen during the month of July and a part of August, until about the 12th; the first seen came from the southeast, and nearly always moved with the wind, especially if strong. During the month of July they were flying almost every day, and at times the swarms were so dense that it was impossible to see through them with a good field glass.

The farmers state that their flying was so regular that no one paid much attention to it; at times the swarms would be more dense than at others, especially if almost calm. Several persons who watched them say that they think they laid but few eggs in the soil this year, and predict few for the next summer.

It will be well here to reiterate the fact that the Rocky Mountain

Locust is sub-alpine, and breeds in greatest profusion in the Rocky Mountain region of the extreme northwest. It thrives best in a high, dry, cold climate, where the summers are short but sufficiently intense. By bearing this fact in mind, we may understand why Minnesota suffers more frequently from the pest than do Iowa, Nebraska, Kansas or Missouri.

The records show that the insect occurs much more frequently in that State than it does further south. Minnesota is unfortunately nearer to the insect's native habitat, and the pest not only extends further east in Minnesota than in any other State (having been known to reach as far as Lake Superior,) but it holds its own better in that climate, and does not so soon succumb to disease and enemies, or so soon leave, as with us.

COLORADO.—This territory, always more or less subject to the locust scourge, was, during the spring of 1875, put under unusually heavy contribution by the insects which hatched in its most highly cultivated sections.

The *Colorado Farmer* for May 6, gives the following account of the situation:

> The locust plague is fairly upon us; the locusts have hatched out in countless millions, and have gone through the early garden and farm crops. From all parts of the territory the cry of "the locusts are upon us," comes with startling force, making strong men quail and women weep.
>
> North and south, from the base of the mountains out to the verge of the plains, the pestiferous locusts have commenced their hateful work. Want and penury stare men in the face who have invested their last dollar in putting in a crop. Eaten out last year, the bouyant hope that has ever characterized Coloradans, induced another trial this season, but it will hardly be possible to tide over the present fearful set-back.
>
> There are, however, some redeeming features; the hoppers can't stay with us always, and they have already commenced to move in a southeasterly direction. Farms that are suitably protected by irrigating ditches are not harmed; wherever the ditches have been filled, nearly all the hoppers that have attempted to cross have perished in the trial. The hard earned experience in the past of Colorado farmers has developed many plans for the destruction of the pests. Among these plans, in addition to the water plan, is destruction by fire—burning straw, in which they seek shelter by night; the use of machines to gather them, and systematically driving them into running water.

The date of hatching varies with the elevation. Mr. N. C. Meeker, of Greeley, writing the latter part of August, says: "On the plains they appeared late in April and the first of May; along the foot hills in May; in the timber region and along the Snowy Range, from June to July. * * * About the first of July the first hatched in the plains region departed torward the south. A week ago, (Aug. 20th,) those hatched in the Blue Mountains came down upon us and then departed in a southeasterly direction, but now we are having them from the Snowy Range in what seems incredible numbers. Their numbers, however, are almost nothing in comparison with the myriads that keep southward every day about noon. I estimate that they cover in the sky east and west a space 20 or 30 miles wide, while they move in a body half a mile deep. They consume about two hours in passing, and one can estimate from this statement how much ground they would cover if they should all alight. * * * *

"Colorado has something like half a wheat crop of most excellent quality, and it is sufficient to provide bread. The deficiency arises wholly from the destruction of crops by the locusts, which hatched a month earlier than common. If they had hatched out at the usual time, the crop would have been a full one, because the wheat would have been too far advanced in growth to have been injured. Thousands of acres of corn were planted in the ruined wheat fields, and the earliest planted is likely to yield well, but with these millions of locusts around us everything is uncertain."

In November a correspondent of the *Colorado Farmer* wrote that "the young locusts were hatching out in great numbers, and that the eggs deposited during the present season were so far advanced toward hatching that large numbers would be destroyed by frost during the Winter and Spring."

Signal Service observations made at Denver show that from the 20th of July to the end of August, swarms repeatedly passed and invariably from the north and northwest, notwithstanding that the prevailing direction of the wind was from the south.

DAKOTA.—Observations made at Pembina and communicated through A. J. Myer, chief signal officer, show that the young locusts began to make their appearance, or to hatch from eggs laid the previous Fall, about the first of June. They matured in about six weeks. The general movement of the winged insects was south, though at times southeast.

About the 10th of August they were seen in incalculable numbers going south, the atmosphere being thick and clouded by them as far as the eye could penetrate, seeming miles in height.

Long before this, however, the insects which left the country to the southeast early in June, passed over the territory in a northwest direction, as the following special dispatches to the Sioux City (Iowa) Daily *Journal*, kindly furnished by Mr. Wm. R. Smith, of that place, will show:

FORT THOMPSON, June 28.—Large clouds of grasshoppers passed over this place to-day, but did no damage. They came from the southeast, and if they maintained their course would bring up in the bad lands of northwestern Dakota and Montana, where their presence will hurt nobody. It is to be hoped they will not light short of that locality.

YANKTON, June 28.—This section is still free from injury by grasshoppers, although many of our people lost heart to-day on seeing the myriads of pests carried along high in air by the wind. Fears were entertained that perhaps something might stop their flight, but as yet we hear nothing of their coming nearer than within eye-shot.

YANKTON AGENCY, June 28.—The hoppers have come and gone without doing damage. Vast swarms passed over this place to-day going in a northwesterly direction, but happily did not light.

FORT SULLY, June 28.—Light clouds of grasshoppers passed over here to-day moving in a northwesterly direction. They did not light and consequently no damage is reported.

FORT RANDAL, June 28.—No damage here from grasshoppers to-day, notwithstanding the air has been full of them flying in the direction of the Whoop-up country.

SPRINGFIELD, June 28.—The grasshoppers went over here to-day, evidently heading for Montana. We are pleased to say that they didn't stop here for luncheon.

Mr. Myer also sends me the following interesting observations made at other points in the Territory by the different signal officers:

BISMARCK.—Locusts first made their appearance in the vicinity of this station on June 6, 1875, and infested this district from that time until the date of their final disappearance, July 15, 1875.

They first made their appearance on June 6, 1875, but not in such quantities as to excite remark—coming from west and southwest; with surface wind fresh to brisk from northwest and weather hazy. On June 7th, during the morning, their numbers perceptibly increased, flying from the South, in small swarms, eight or ten feet thick, with the surface wind west and southwest. During the afternoon with gentle south wind the grasshoppers rose and flew north; very few being visible near this station that night.

On June 8th they returned gradually from the north, and for the first time began to eat the crops, and during the day were reinforced by a light swarm from the southeast—surface wind from west and northwest. Remained during June 9th, eating but little. On June 10th a storm of wind and rain from the east swept over this station, which appears to have dispersed them, very few being seen in this vicinity until June 29. On that date, a small swarm, estimated as being about five hundred yards square and from ten to twelve feet thick came from the south, the surface wind being from the northwest. This swarm settled but did no damage that I could hear of, and no more arrived until July 7th. On that day a swarm made its appearance before which the previous visitations sank into insignificance. The day was very warm with hazy weather and gentle south winds. At 10 A. M. the locusts were first noticed on the southwest bank of the Missouri river, and in such quantities as to resemble heavy banks of stratus clouds. They passed over this station, without intermission from 10 A. M. to 4 P. M., with a peculiar "whirring" noise caused by movement of so many millions of wings. It was almost impossible to estimate the extent and thickness of this swarm, extending from twenty feet above the ground, high into the air, probably two hundred feet; and as far as the eye could reach to any point of the compass, the air was full of the insects. At 4 P. M. they began to settle on the ground and by nightfall the ground was covered with them.

On the morning of July 8th another swarm estimated to be about half as large as the one mentioned above, came with the surface wind from southwest, and settled on the ground with their predecessors.

During the 9th and 10th July, the locusts devoured nearly everything green in this vicinity, and inflicted great damage to all crops except potatoes, in which the loss was estimated to be 25 per cent. Cabbages and turnips were almost wholly destroyed. The total damage done to all crops is estimated at 60 per cent.—excluding the potato crop. Had all the crops been ripe at this time, a total destruction would no doubt have ensued.

After July 10th, the locusts rapidly became less, many dying and the balance slowly moving north and west; and after July 15th, they had wholly disappeared.

YANKTON.—On June 17 the wind was strong from the east; the locusts were going with it to the west. On June 28 the wind was moderate from the south. Great swarms of insects were going with it north. On June 29 the wind was northeast, moderate. A good number of locusts were traveling southwest.

FORT SULLY, June 15th.—[Direction of wind, as ascertained by the records: 6 A. M. to 7 A. M. northeast, then east till 10 A. M., then south till 3 P. M.; southeast remainder of day.] Several days previous to this date I had been hearing of the approach of locusts along the line of telegraph from Omaha upward to northwest, and at 4 P. M. of the 14th the operator at Fort Thompson (85 miles south, 25° east from Fort Sully) reported their advance flying northwest and northwardly. At noon a large cloud of the insects passed over until night when they were no longer visible. Roughly estimated the swarm may have been about 50 miles long, 25 wide and ¼ to ½ mile in height. A hail storm the following day may have dispersed them.

June 23.—[Direction of wind: 6 A. M., southeast; 7 A. M., southeast; 10 A. M., southeast; 2 and 3 P. M., east; rest of day calm.] Large flights of locusts passing over during the morning, going north and northwest at an estimated elevation of about 50 feet to as high as they were visible with field glasses, possibly a mile; none alighting. This swarm, as near as could be ascertained by telegraph at the time, came from the Minnesota infested region along the line of the Sioux City and St. Paul Railroad in a continuous cloud, probably 1,000 miles long from east to west, and 500 miles from north to south. How much farther north of this post, unascertained, and not conjectured.

June 24.—[Morning calm; west wind at noon, followed by southeast in evening and night.] Straggling locusts began to fall, the flight still continuing northwest. During the afternoon they commenced to alight and the post garden vanished from the earth. Their increasing numbers resembled smoke at a short distance, many thinking there was a large prairie fire, the resemblance being very close.

June 25.—[Wind north until night, then southeast.] Locusts so thick along the bottom land as to hide the ground in places. Prairie also covered with them. Large numbers still flying. In some places they drifted into disgusting heaps, from six inches to a foot in depth, and where trodden upon by horses, etc.; they rendered those locations very uninviting in appearance and odor.

June 26.—[Wind east till 3 P. M.; then northeast, and at night north.] Remaining as the day before.

June 27.—[Wind north till 3 P. M.; southeast at night.] Began arising.

June 28.—[Wind southeast till 10 A. M.; west at 2 P. M.; north at night.] Disappeared from ground and by night none were seen in the air. They flew away northwest.

August 6.—Large numbers passed over but less than on previous occasions, (stragglers fell) passing northwest.

August 7.—Still passing northwest.

August 8.—Same swarm going northwest. A severe thunder storm arose and about 8 P. M. hailstones fell. When this storm passed the last locust seen this year had fled northwest.

MONTANA.—I have been unable to obtain any satisfactory data from the editors of any of the journals published in the Territory, all of whom I addressed with stamp enclosures. The tendency is so great among such to depict the Territory an Eden with no drawbacks, that they invariably claim to be out of the line of the locusts. The following observations were recorded at Virginia City in the extreme southwest of the Territory, and received from Mr. Myer. After stating that the insects moved west on the 18th of July; a little south of west on the 19th; southwest on the 20th, 21st and 22d, and southwest on the 7th of August; and that the wind was from northeast and southwest on the 18th, west and southwest on the 19th, southeast and northwest on the 20th, east and northeast on the 21st, southwest and west on the 22d and northwest and west on the 7th of August, the observer continues:

The locusts were thickest on July 20th and 21st, giving the sun a hazy appearance.

These "emigrant" locusts came from the plains of Dakota, and were here, the largest bodies on the above mentioned days, at least half a mile in thickness, and, as I learn from reliable authority, they presented an unbroken width of twenty miles, being even more numerous on the wings than here, near the centre.

A great many stopped here on the 20th, clinging to fences, etc., as if exhausted. They were numerous around Helena, Bozeman, Deer Lodge, and other towns in that portion of Montana Territory, the general course taken being southwest.

The following observations, received from the same source, were made at Benton:

Large quantities of locusts devastated the country west of this place, but there being no arable land nearer than Sun river, sixty miles distant, they were not so plenty here, although large quantities were at this place during July and August. They moved principally southwest and northwest. The wind was principally west, and the swarms at Sun river large enough to darken the sky. I find no mention of them in the journal except on July 27th and 28th, and that states that they did not seem to be traveling in any particular direction.

WYOMING.—Signal Service observations made at Cheyenne, show that the young locusts were very numerous during the latter part of May on bottom lands; and the observer records the following somewhat later in the season:

August 6th. A number of locusts were seen moving south; wind from northeast, at P. M.

August 8th. A great many locusts were observed at 2 P. M., moving from northwest; apparently carried by the northwest wind, they moved to the southeast.

August 23d. An immense swarm of these insects alighted from east to southeast. apparently compelled to by the brisk northwest wind.

August 24th. Most of the locusts left to-day, moving west and northwest; wind being light to fresh from north to south. I noticed a few, upon my return to the station, September 30, and October 1.

I did not learn of any serious damage from these pests, owing, I suppose, to the fact that agriculture is not carried on in our vicinity.

A series of questions, as to the course of the insects, which I published in the Daily *News* of Laramie City, failed to bring me any answers.

TEXAS AND INDIAN TERRITORY.—The insects are reported as having hatched in large numbers early in the Spring in Northern Texas and Indian Territory; but while gardens were often ruined, little damage was done to the growing grain. The Signal Service officer at Fort Gibson, I. T., reports that—

There were three distinct swarms seen about the first of May; the exact date I am unable to ascertain. They seemed to have had their origin from a deposit of eggs during the preceding year, and left the neighborhood as soon as they were able to fly. The first two lots moved toward the northeast, with the surface winds blowing from the south; the third swarm, on the contrary, moved towards the southwest, with a northeast wind.

They were leaving during most of the month of May, and generally north. A dispatch from Fort Gibson, dated June 1, says:

Millions of locusts essayed their new wings on Sunday, rising like swarms of bees and started in a westerly direction. The air was filled like a cloud over the sun at ten o'clock. The Grand, Verdigris and Arkansas rivers were covered with the dead hoppers that failed to fly across at the start. We bid them adieu without a pang of regret.

They were not noticed as far south as Corsicana, Texas, but were observed to be numerous at Dallas, sixty miles to the north.

MANITOBA.—Little or no cultivation was attempted in many parts of Manitoba, owing to the prevalence of locusts in the Spring. Mr. G. M. Dawson, in an interesting pamphlet "on the Locust Invasion of 1874 in Manitoba and the Northwestern Territories," just published in Montreal, remarks that "the position of Manitoba, near the north-eastern limit of the range of the locust, is in so far favorable as it is only exposed to invasions from directions included between west and south; and the prevailing winds being northwesterly and coinciding with the direction of the migration instinct of the insect, carry the greater number of the swarms from their breeding places to the South-western States. The northern situation of the province also tends to exempt it from a double visitation, first from southern, and then from northern and northwestern broods." He states, however, that the number of the insects borne to Manitoba, is more than sufficient to produce great injury.

AMOUNT OF DAMAGE DONE IN MISSOURI.

In making an estimate in figures of the amount of damage done by the locusts, several important considerations must be kept in view. First, it is impossible to arrive at strict accuracy, for we have no such means of collecting facts covering a whole county, as would enable us to ascertain the exact damage upon each farm or quarter section. Then, the amount of injury to fruit and gardens, and the permanent injury to fruit trees, meadows and pastures, can scarcely enter into our calculation. The number of improved acres varies in counties of nearly the same area. Different counties received different measures of harm, owing to the different character of the surface, the relative amount of timber, etc.

The immediate damage was the loss of labor expended in planting, and the seeding for about two thirds of the crop acreage of the country, to which the destruction of the tame grasses and of fruit may be added. The value of these it is difficult to get at. I have requested a number of correspondents to give an estimate of the probable damage in their county from the young locusts, and I append a few of the answers as samples, from counties which received the greatest injury. Many find it impossible to make an estimate, while a few deem that their counties, for one reason and another, were not materially injured by the locusts.

The loss to Lafayette county was fully two millions of dollars.—[J. BELT, Napoleon, Lafayette Co.

I estimate the damage done in this county to be at least 50,000 dollars.—[ELIHU CANADAY, Ionia City, Pettis Co.

The damage in our county was not very heavy, as the insects hatched late, when there was already abundance of vegetation to feed upon, and they did not spread over the whole county. There were none east of Sedalia, while they were numerous south, west, and northwestward. I do not think the damage in the county amounted to over $50,000 in all, while their depredations created a demand for much of our produce further west.—[GEORGE HUSMANN, Sedalia, Pettis Co.

The damage to our county by the young locusts in the Spring of 1875 would not fall far short of seventy-five thousand dollars. — [JNO. L. MODREL, Little Osage, Vernon Co.

I suppose half a million dollars would be the lowest estimate that could be given. —[J. L. MOTSINGER, Fayetteville, Johnson Co.

The damage was immense. Our county will not get over it for years. Nearly one-half of our farmers are bankrupt. Deeds of trust are on one-half of the lands.—[B. F. Dunkley, Dunksburg, Johnson Co.

The damage done to the three-fourths of Lafayette county invaded, has been estimated to be not far from two and one half millions ($2,500,000). — [JAS. E. GLADISH, Aullsville, Lafayette Co.

$2,380,000. In making an estimate of the loss to the county from ravages of locusts, I would state that we put it at the very lowest figures from actual calculations. —[Dr. Jno. L. GREGG, Stony Point, Jackson Co.

If I had the statistics showing how much clover and timothy was destroyed, how much oats and wheat, and how much of the same was planted in corn, and what the average crop raised in comparison with what would have been the average if the earlier planting had stood, and also to what extent the soft corn is being and will be utilized —if I had a perfect knowledge of these things I might make an intelligent answer.— [W. S. PARRISH, Hickman Mills, Jackson Co.

The damage to Jackson county in the Spring of '75 would exceed two million dollars.—[Z. S. RAGAN, Independence, Jackson Co.

To enumerate by counties, the following figures approximate the real loss sustained from the injury to grains alone:

Atchison $700,000; Andrew $500,000; Bates $200,000; Barton $5,000; Benton $5,000; Buchanan $2,000,000; Caldwell $10,000; Cass $2,000,000; Clay $800,000; Clinton $600,000; DeKalb $200,000; Gentry $400,000; Harrison $10,000; Henry $800,000; Holt $300,000; Jackson $2,500,000; Jasper $5,000; Johnson $1,000,000; Lafayette $2,000,000; Newton $5,000; Pettis $50,000; Platte $800,000; Ray $75,000; St. Clair $250,000; Vernon $75,000; Worth $10,000.

The foregoing estimates exceed the amount of $15,000,000. They are arrived at, in the majority of instances, by combining the following elements: the number of acres of crops destroyed; the average amount of the crop; and the value of the crop, allowing forty cents a bushel for corn, one dollar for wheat, one dollar and a half for barley, and thirty cents a bushel for oats. The amount of loss redeemed by crops that succeeded after the insects left, it is impossible to determine; and yet this amount may again be offset by the injury both temporary and permanent, to fruit, fruit trees, vineyards, gardens, meadows and pastures; by the fact that such crops as flax, castor-beans, etc., have not been estimated in the calculation; and lastly, by the injury to stock, the animals necessarily driven out of the country, and the general depreciation of property. The counties of Cedar, Dade, Hickory, Lawrence, McDonald, Nodaway, and Polk, have, moreover, been omitted from the calculation, for want of sufficient data on which to base estimates.

THE DESTITUTION IN MISSOURI.

From the facts already detailed under the heads of the different counties, it will readily be inferred that the same portion of the State has never before been visited by a calamity so appalling, and so disastrous in its results, as the locust ravages of 1875. Other years have brought drought, chinch bugs, and partial or total failure of particular crops, but no event ever before so completely prostrated the country within which the ravages occurred. The suddenness and desolating power with which the attack came, where often the possessor of promising crops deemed them safe, acted as a paralysis upon those very faculties that are engaged in the forethought and deliberation necessary to self-preservation or concerted action. The farmer saw his green acres smiling with glorious hope to-day, and to-morrow, perhaps, all barren and bleak as in winter. It is no wonder that many communities were panic-stricken. Previous disaster had already brought many sections to a critical and suffering point, so that even during the winter the Legislature was appealed to for aid. Stock had been dying; feed of all kinds was scarce, and whole communities were relying on the promise of the Spring. For this reason the locust ravages were all the more desolating and discouraging. I subjoin a few extracts as a record of the destitution that occurred:

It would be useless for me to attempt to describe the ravages of the grasshoppers. You can form some idea of their voracity from the fact that they have eaten lint and decayed wood from the fences, and unpainted houses are gnawed all over, and they are now consuming the last year's corn stalks. In addition to our present disasters, I fear that disorder is not far away. There is an uneasy, if not desperate feeling in many localities, and those having provisions are secreting them. The press is not telling the whole truth. A few nights since a body of armed men, who said they were from Bates county, took all the flour from the Kingsville mill, and it has not been published. Many other ugly facts are suppressed.—[Extract from a letter from Abram Helms, of Holden, to H. M. Williams, Jefferson City.

We must have aid, or many will be compelled to abandon their crops. We have not the seed to plant with, or the money to buy. Season too far advanced for anything except corn, late potatoes, navy beans and millet. Can you help us by donation or loan. The condition of our county is truly alarming. People have become discouraged; many are talking of leaving their homes; some are living on bread and water. Unless we get assistance from some quarter, many are bound to suffer. Holden and East Lynn are our shipping points. Can get better rates to Holden than any other place convenient.—[Letter to Master T. R. Allen by a committee appointed at Altona, May 25.

I am now out of funds, while the distress is more imminent than at any time since we began our relief effort. From Benton, Bates, Cass, Johnson, Henry, St. Clair, and from Lafayette and Jackson counties, the appeals are most urgent and pathetic.—[Extract from a letter, May 21, from State agent A. J. Child to T. R. Allen.

From Galbreath's store, Henry county, comes the statement "that there are many families who will actually starve if they are not assisted." The agent of the State Grange, A. J. Child, who has been distributing corn supplied by the grange, writes from Appleton City, St. Clair county: "It grows worse and worse, and God only knows what the future of many of these inhabitants is to be. They are out of everything and have exhausted every available means of credit in their efforts to live and get crops started, and now the chinch-bugs and grasshoppers are cleaning up everything like a consuming fire. I am overpowered and overwhelmed by disclosures of the fearful want, and the equally fearful outlook." Judge Woods, of the Henry county court writes: "I cannot see how our people are to get through the next two months, as there is not enough bread-stuff in the county to keep them from starvation. If it were here, they have no money to buy with. Those who had a little corn had to feed it in order to save their stock, and now they are out of corn, money and credit. Hundreds are living on bread and water." A letter from Kingsville, Johnson county, says: "The condition of things in the western part of our county is perfectly distressing. Men are growing desperate, and already threaten to divide out by force what there is in the county, and we all know that when such a move is once made, the worst men in the county will take the lead."—[*St. Louis Republican*, about the middle of June.

I do not exaggerate, but state the simple truth when I say that I have been time and again over the most of this (Polk) township, and I do not believe there is *one sprig* of timothy, clover, wheat or corn left standing an inch above the ground in the township; that not a bundle of oats will be cut; not a pound of hay or grass of any kind will be saved this season; vegetables of every kind have been totally destroyed, and all the fields, without a single exception, so far as I have been able to learn, are as bare of vegetation, even weeds, as newly ploughed ground—notwithstanding the fact that some farms have been planted as often as twice and three times this season, and the wild grass and weeds on the outlands in both prairie and timber, have either been entirely devoured or cut down so close to the ground that cattle have been and still are starving to death by hundreds. The owners having in many cases paid out all their money, sold everything they could get along without, and mortgaged their farms to get money to carry their stock through the winter and plant their crops, now are left with nothing to eat, their stock have starved to death, and they have no money, and no means of raising any by loan or mortgage, to buy food or to get away from here to more favored sections of the country.—[*Globe-Democrat* Correspondence from Strasburg, Cass Co., June 16.

My own impressions received at the time, may be gathered from the following remarks made at a meeting of the merchants of St. Louis, held at the Merchants' Exchange, May 28, for the relief of the destitute, and reported in the St. Louis papers:

I have just returned from the district of Pettis, Johnson and Cass counties, and from reports I have had from Vernon, Bates and Johnson counties, I can form a pretty correct conclusion as to the actual state of things there. One reason why reports are so contradictory is mainly because you will find districts in the same county very differently affected. I believe that Cass county is about the worst off, and actually the devastation by the locusts in that county cannot be exaggerated. You may go from one end of that county to the other, and with the exception of forest trees, where there is timber, and here and there a low piece of moist prairie, or occasionally an oat field, there is not a trace of vegetation to show you that it is the growing season; the country is as bare and desolate as in mid-winter. The only vegetation remaining in the fields consists of a few stalks of milkweed (*Asclepias*), which is about the only conspicuous plant they do not relish.

Very much the same state of things occurs in the adjacent counties, and the distress is great.

I find among the people in the stricken district generally a determination to overcome the difficulties, and, as far as possible, to relieve their own people. The well-to-do citizens feel inclined to relieve their own counties as far as possible, and with few exceptions there is no actual distress. The greatest want is mainly on account of the scarcity of seed. Some families will need rations and food to keep them from starvation until they can bridge over the present destitution, but as a rule the need is mainly for seed for the different crops. They need corn that will mature early, buckwheat, Hungarian grass, vegetable seeds, potatoes—everything that will soon mature, and this they want immediately.

It is impossible to say how long those sections in the several infested counties, which are now in a flourishing condition, will remain so. The probabilities are that during the next week most of the crops in those sections will be destroyed, and that they in the end will suffer more than the counties which have so far suffered most. There has been a great deal of talk among a few idlers and loafers and desperate characters, of raids on the towns and on those who have supplies. But the committees appointed, especially in Johnson county by authority of the County Court, investigated the real state of affairs, and have reported that there was really no actual destitution in that county, and that all these threats were made by desperate characters, who would not work if they had the chance.

Efforts are now being made to relieve this pressing necessity for seed. I am confident that the prediction I have made will be verified. The people will yet raise in those counties, in all probability, the largest crops of corn they ever raised. The locusts having killed off the herbage from the ground, the hosts of noxious insects that fed on it have also been annihilated. There is not a weed left, and the ground is in the best possible condition to receive seed. By the time it comes up I believe the insects will have been decimated by parasites and starvation, so that the crops will receive little injury; that the insects will not materially advance beyond the eastern line they have now reached. Already they are dying in immense quantities; and they will soon acquire wings and leave. Thus the fears of some that they threaten to be a permanent pest, and that it is of no use to plant because the insects will eat everything as fast as it comes, are groundless.

I would urge all farmers to put forth their best efforts to plant seed for such crops as will mature soon. I would especially urge the planting of more root crops, such as turnips, beets and mangel wurzel, which will furnish nutritious food for stock. We must not forget that the area now being devastated, compared with the area overrun last fall is small, and the present severe devastation is confined to some dozen counties, whereas in the rest of the State the crops are promising most abundantly. I really hope that no aid will be asked outside of the State.

There are a number of ways in which the insects can be destroyed. By means of ropes, conveying screens and nets, they can be caught in large quantities. They may be trapped in ditches. If it had been possible for Governor Hardin to offer a bounty for every bushel of the insect, that could have been captured throughout that district, it would have afforded employment to hundreds of people who have now nothing to do. From a conversation I had with Governor Hardin, I am of the opinion he would gladly have taken that step. When I suggested last winter that a law should be passed offering a bounty for the eggs, the idea was ridiculed, but the people see now how wise such a course would have been. A few thousand dollars appropriated by the Legislature for the purpose would have been the means of averting the present injury.

The meeting above referred to resulted in the appointment of a committee by the Directors of the Exchange, for the purpose of soliciting aid; and the committee at once issued the following circular:

ADDRESS OF THE COMMITTEE.

The undersigned, a committee appointed by the Merchants' Exchange, and acting under the advice of the Governor, to appeal to the charitable people of St. Louis, and the State of Missouri at large, in behalf of our fellow-citizens of the counties of Cass, Vernon, Henry, Bates, Jackson and other border counties of the State, now infested and overrun by locusts, beg leave to submit the following suggestions: From conversation and correspondence with numerous parties whose statements can be relied upon, we are convinced of the *great necessity* for the immediate relief of these people. The demand is more especially for seeds for replanting to enable them to subsist during the coming winter.

The committee beg leave to recommend that the people of other cities and counties in the State organize local relief committees to co-operate with this committee, or send supplies directly to the committees appointed by Governor Hardin. Supplies or money sent through this committee will be strictly applied to the relief of the destitute, under the supervision of proper and responsible sub-committees.

The committee are satisfied, from information obtained through Prof. C. V. Riley, State Entomologist, that the insects will not extend far beyond their present limits, and that they will gradually disappear from the counties now infested—the great demand being for immediate and present relief.

Donations are specially asked for in the following *seeds*, viz.: *Early corn* (grown as far north as possible), *millet*, *Hungarian grass*, *rye*, *oats*, *buckwheat*, *beets*, *turnips*, *mangel wurzel*, *potatoes*, *cabbage*, *tomatoes*, *sweet potato plants*, *peas*, *beans*, *broom corn*, *sorghum* and other garden seeds in season. Food—Corn meal, flour, cured meats and salt. Forage—Corn, oats, hay and any other forage for stock.

Donations in any of the above articles may be sent to the Central Elevator, corner of Twelfth and Austin streets; Pacific Railroad track; Henry Ames & Co., No. 1001 North Main street; E. M. Samuel & Sons, Levee and Vine; or W. M. Price & Co., No. 14 South Main street. On notice left with any of the committee, donations will be called for.

John M. Gilkeson, Chairman,	L. L. Ashbrook,
Joseph A. Wherry,	Samuel M. Dodd,
John T. Davis,	W. R. Jouett,
Miles Sells,	R. M. Adams,
Jos. S. Nanson,	Webb M. Samuel,
John W. Larimore,	T. G. Conant,
A. H. Smith,	C O. Dutcher,
John B. Maude,	Thomas Booth,
Ch. Bartlett,	W. M. Senter,
W. P. Howard,	W. M. Price,
D. W. Marmaduke,	Committee.

It is hardly necessary to state that the Committee did not cease its efforts till the 22d of June when there began to be no further occasion for them. The sympathies of our citizens were aroused and large amounts of supplies of all kinds, and especially of seeds were at once sent out to the stricken districts. Aside from the good relief work done in other favored parts of the State, outside St. Louis, the efforts of T. R. Allen, Grand Master Patrons of Husbandry, are particularly worthy of mention. He took an active part, and deserves the thanks of the people. He traveled through the more fortunate sections of the State, and personally plead for the sufferers and solicited subscriptions, and in this way succeeded in doing much good.

Some cases of actual starvation were reported in the papers, but I have been unable to learn of a single authenticated instance where the names of parties could be given. Replies to the question, "Did any cases of actual destitution or starvation positively occur in your county?" from over a hundred correspondents in counties which suffered most, with scarcely an exception have been to the effect that while there was great destitution no cases of starvation occurred. The following are a few of the most gloomy statements:

Severe destitution prevailed, and I think in some cases, perhaps death from disease was hastened from want of proper food.—[J. H. Lay, Warsaw, Benton county.

Cases of actual destitution and starvation positively did occur. A large number of families were compelled to leave our county. They were forced to get out to procure bread for their starving children—among whom were some of our best families.—[A. C. Loveridge, Harrisonville, Cass county.

There was no starvation, but undoubtedly would have been, if assistance had not been given.—[H. L. Hewitt, Austin, Cass county.

There were many cases of partial destitution in this county, but none of actual starvation that I know of.—[Wm. A. Smith, East Lynne, Cass county.

No cases of starvation to my knowledge, but great destitution.—[W. H. Barron, Raymore, Cass county.

None to my knowledge, although some were in straitened circumstances for food and were aided by their more fortunate friends.—[Dan. Carpenter, Barry, Clay county.

There were cases of extreme destitution, but none of starvation.—[D. C. McIntire, Norris Fork P. O., Henry county.

There was destitution but no starving that I know of.—[I. J. Quick, Gaines Farm, Henry county.

No cases of starvation occurred to my knowledge, but many were put on short allowance, and much stock actually perished for want of food.—[Z. S. Ragan, Independence, Jackson county.

To my knowledge, I cannot say that any person starved to death directly, but hundreds and thousands of men and beasts did not get the necessaries to keep them up in vigor and strength, required to do the work allotted to them after the destruction. I knew several to say they put their crops in on bread and water, and the bread gave out and they had to leave for other parts to make a living; and thousands were compelled to mortgage and pledge their property. It was represented by some of the wealthy money mongers that Johnson county could take care of her destitute, which prevented much assistance and aid for distribution from coming here; though considerable was sent and distributed by the society of Dunkards, Granges and other individuals, and this alleviated our situation very much.—[John Zimmerman, Warrensburg township, Johnson county.

Destitution did exist, but probably no positive starvation, in this immediate vicinity.—[Calvin A. Mark, Warrensburg, Johnson county.

No; the good people of St. Louis, and other parts of the State, prevented starvation, and the rich helped the poor everywhere in the county.—[B. F. Dunkley, Dunksburg, Johnson county.

We think not, but many families were upon very short allowance a considerable time, having nothing to eat but poor bread and water.—[J. T. Ferguson, Linabar, Lafayette county.

There were cases of destitution, but aid from abroad, and assistance at home, prevented any cases of starvation.—J. Belt, Napoleon, Lafayette county.

None, to my knowledge, but there must have been much suffering, and even death, but for the praiseworthy response of the citizens of both Lafayette and other counties, as well as the city of St. Louis.—[Jas. E. Gladish, Aullsville, Lafayette county.

There were many cases of actual destitution in this county, but none of starvation.—Jno. L. Modrel, Little Osage, Vernon county.

THE GOVERNOR'S PROCLAMATION.

The general interest awakened in the various endeavors to aid the sufferers was, without doubt, largely due to the active sympathy and the prompt attention given to the subject by Governor Hardin. About the middle of May he issued the following proclamation:

Whereas, owing to the failures and losses of crops much suffering has been endured by many of our people during the past few months, and similar calamities are impending upon larger communities, and may possibly extend to the whole State, and if not abated will eventuate in sore distress and famine;

Wherefore, be it known that the 3d day of June proximo is hereby appointed and set apart as a day of fasting and prayer, that Almighty God may be invoked to remove from our midst those impending calamities, and to grant instead the blessings of abundance and plenty; and the people and all the officers of the State are hereby requested to desist, during that day, from their usual employments, and to assemble at their places of worship for humble and devout prayer, and to otherwise observe the day as one of fasting and prayer.

In testimony whereof, I have hereunto set my hand, and caused the great seal of the State of Missouri to be affixed, in the City of Jefferson, this 17th day of May, 1875.

C. H. HARDIN.

By the Governor:

M. K. McGrath, Secretary of State.

This proclamation naturally drew forth a large amount of comment, and our worthy Governor was ridiculed or praised according as fancy inspired newspaper men. As I was myself taken to task by no less a personage than the Reverend Doctor W. Pope Yeaman of the Third Baptist Church of St. Louis, for supposed ridicule and for taking "unnecessary pains to sneer at Providence," it may be as well to state that the only sentiment I ever expressed, either by word of mouth or by pen, as to the proclamation, is contained in an article published in the St. Louis *Globe* of May 19, where I wrote:

> I deeply and sincerely appreciate the sympathy which our worthy Governor manifests for the suffering people of our western counties, through the proclamation which sets apart the 3d of June as a day of fasting and prayer that the great author of our being may be invoked to remove impending calamities. Yet, without discussing the question as to the efficacy of prayer in affecting the physical world, no one will for a moment doubt that the supplications of the people will more surely be granted if accompanied by well-directed, energetic work. When, in 1853, Lord Palmerston was besought by the Scotch Presbyterians to appoint a day for national fasting, humiliation and prayer, that the cholera might be averted, he suggested that it would be more beneficial to feed the poor, cleanse the cesspools, ventilate the houses and remove the causes and sources of contagion which, if allowed to remain, will infallibly breed pestilence, "in spite of all the prayers and fastings of a united but inactive nation." We are commanded by the best authority to prove our faith by our work. For my part, I would like to see the prayers of the people take on the substantial form of collections, made in the churches throughout the State, for the benefit of the sufferers, and distributed by organized authority; or, what would be still better, the State authorities, if it is in their power, should offer a premium for every bushel of young locusts destroyed. In this way the more destitute of the people in the infested districts would have a strong incentive to destroy the young locusts, and thus avert future injury, and at the same time furnish the means of earning a living until the danger is past. The locusts thus collected and destroyed could be fed to poultry and hogs, buried as manure, or dried, pulverized and sold for the same purpose.

As stated in my reply to Dr. Yeaman, "my intercourse with Governor Hardin has led me to honor him as a Chief Magistrate whom the State will learn to appreciate more and more, and I hold him in too great respect to have much sympathy with the mere flippant ridicule that has been made of the proclamation. Though I may not have overmuch piety and faith myself, I at least know how to respect those qualities in others, and however much I believe that the insect which was the remote cause of Dr. Yeaman's sermon is governed by natural laws, which should guide us in understanding and overcoming it, the reverend gentleman forgets his calling, and makes himself ridiculous, in charging, for such reasons, that I 'sneer at Providence.'"

As the most effective and substantial method of observing the day of fasting and prayer, Gov. Hardin on the 24th of May, wisely issued a second proclamation, urging the benevolent and charitable, who might assemble on the 3d of June in public worship, and felt so disposed, to make contributions and forward the same to Jesse Chilton, Harrisonville, Cass county; R. B. Harwood, Warrensburg, Johnson county; Dr. G. Y. Salmon, Clinton, Henry county; Dr. G. N. V. Dodson, Nevada, Vernon county, and F. G. Tygard, Butler, Bates county, and to the presiding judges of such other counties as are known to need relief.

The third of June was well observed in most parts of the State, and the observance of the day was productive of good not only by the collections taken up in the different churches for the sufferers, but by reassuring and encouraging many good people who could have been reassured in no other way.

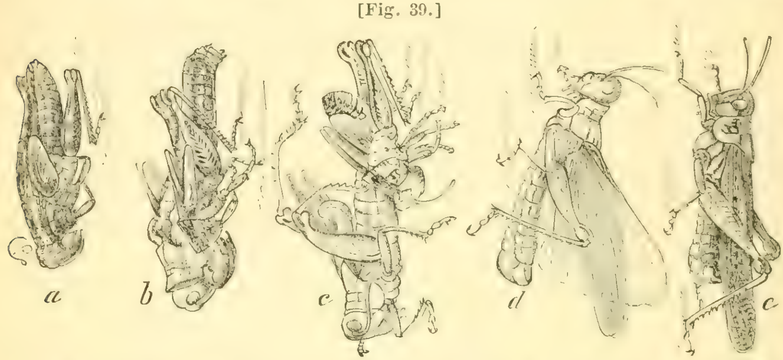
NOT A DIVINE VISITATION.

There are those, both among the clergy and the laity, who deem such a visitation as that from which our western counties suffered, an expression of Divine wrath, for the sin and corruption of the people—a chastisement of the Lord. They claim that the "wickedness, fraud, falsehood, and corruption" which, as they assert, "abound in every department of society," are at the bottom of it. They consider it impious to attempt to avert the evil. These opinions were boldly proclaimed by a correspondent of the St. Louis *Republican*. The expression of such opinions was a downright insult to the hard-working, industrious, and suffering farmers of the western country, who certainly deserve no more to be thus visited by Divine wrath than the people of other parts of the State and country. Persons who promulgate such views are little removed in intelligence from the poor crack-brained negress whom I saw in the streets of Warrensburg shouting and imploring the people not to kill a locust, since God Almighty had sent them; or from the poor deluded Arabs who make no effort to destroy the locusts which they believe to be the "army of the Great God." It is not surprising that people are yet found who hold such views; for no great calamity ever befell a country which was not attributed, by certain fanatics, to Divine wrath; but it is surprising that, in this enlightened day, such persons can, without editorial reproof, find circulation for their vagaries in the columns of some of our widely circulating and influential journals.

NATURAL HISTORY.

In addition to what was said under this head a year ago, a more detailed account of the process of molting may here be given. In order to illustrate this interesting process we will trace an individual through the last molt—from the pupa to the winged insect—as it is the most difficult, and, on account of the larger size of the animal, most easily watched. The other molts are very similar, except that the wing-pads increase but moderately in size with each. When about to acquire wings the pupa crawls up some post, weed, grass-stalk or other object, and clutches such object securely by the hind feet which are drawn up under the body. In doing so the favorite position is with the head downward, though this is by no means essential. Remaining motionless in this position for several hours, with antennæ drawn down over the face, and the whole aspect betokening helplessness, the thorax, especially between the wing pads, is noticed to swell. Presently the skin along this swollen portion splits right along the

[Fig. 39.]



ROCKY MOUNTAIN LOCUST :—Process of acquiring wings ; *a*, pupa with skin just split on the back ; *b*, the imago extruding; *c*, do. nearly out; *d*, do. with wings expanded; *e*, do. with all parts perfect.

middle of the head and thorax, starting by a transverse curved suture between the eyes, and ending at the base of the abdomen. Let us now imagine that we are watching one from the moment of this splitting, and when it presents the appearance of Fig. 39, *a*. As soon as the skin is split, the soft and white fore-body and head swell and gradually extrude more and more by a series of muscular contortions; the new head slowly emerges from the old skin which, with its empty eyes, is worked back beneath; the new feelers and legs are being drawn from their casings, and the future wings from their sheaths. At the end of six or seven minutes our locust—no longer pupa and not yet imago—looks as in my Fig. 39, *b*, the four front pupa-legs being generally detached and the insect hanging by the hooks of the hind feet, which were anchored while yet it had that command over them which it has now lost. The receding skin is transparent and loosened, especially from the extremities. In six or seven minutes more of arduous labor—of swelling and contracting—with an occasional brief respite, the antennæ and the four front legs are freed, and the fulled and crimped wings extricated. The soft front legs rapidly stiffen and, holding to its support as well as may be with these, the nascent locust employs whatever muscular force it is capable of to draw out the end of the abdomen and its long hind legs (Fig. 39, *c*). This in a few more minutes it finally does, and with gait as unsteady as that of a new-dropped colt, it turns round and clambers up by the side of the shrunken cast-off skin, and there rests while the wings expand and every part of the body hardens and gains strength—the crooked limbs straightening and the wings unfolding and expanding like the petals of some pale flower. The front wings are at first rolled longitudinally to a point, and as they expand and unroll, the hind wings which are tucked and gathered along the veins, at first curl over them. In ten or fifteen minutes from the time of extrication these wings are fully expanded and hang down like dampened rags (Fig. 39, *d*). From this point on, the broad hind wings begin to fold up like fans beneath the narrower front ones, and in another ten minutes they have assumed the normal attitude of rest. Meanwhile the pale colors which always belong to the insect while molting have been gradually giving way to the natural tints, and at this stage our new-fledged locust presents an aspect fresh and bright (Fig. 39, *e*). If now we examine the cast-off skin we shall find every part entire with the exception of the rupture which originally took place on the back; and it would puzzle one who had not witnessed the operation to divine how the now stiff hind shanks of the mature insect had been extricated from the bent skeleton left behind. They are in fact drawn over the bent knee joint, so that during the process they have been bent double throughout their length. They were as supple at the time as an oil-soaked string, and for some time after extrication they show the effects of this severe bending by their curved appearance.

The molting, from the bursting of the pupa skin to the full adjustment of the wings and straightening of the legs of the perfect insect, occupies less than three-quarters of an hour and sometimes but half an hour. It takes place most frequently during the warmer hours of the morning, and within an hour after the wings are once in position the parts have become sufficiently dry and stiffened to enable the insect to move about with ease, and in another hour, with appetite sharpened by long fast, it joins its voracious comrades and tries its new jaws. The molting period, especially the last, is a very critical one, and during the helplessness that belongs to it the unfortunate locust falls a prey to many enemies which otherwise would not molest it, and not unfrequently to the voracity of the more active individuals of its own species.

As stated a year ago (Rep. 7, p. 123) there are four molts exclusive of that which takes place upon leaving the egg. In the first stage—that following the egg—the wing-pads are not visible; in the second (after the first molt) they project but little beyond the meso and metathorax, differ but little in size, and are directed downwards, lying separately close to the body: in the third stage (after second molt) they are directed upward, the hind covering and hiding more or less the front pair, and the joints bearing them retreating more beneath the prothorax: in the fourth stage (after third molt) they are enlarged as seen in the pupa, and with the fourth molt the fifth or perfect stage is attained. European authors differ as to whether there are three, four or five molts in the European migratory species;* but I have watched *spretus* from the egg to the imago, and thousands of mounted and alcoholic specimens of all ages, show distinctly the five stages enumerated, and these only.

HABITS OF THE UNFLEDGED LOCUSTS.

Never having had before the opportunity of observing the habits of the young insects as they hatch out in the Mississippi Valley, the experience of last Spring was very interesting to me, as well as valuable. As I had stated they would, the great bulk of these young hatched out about the middle of April, but others kept on hatching even up to the time when the first hatched got wings, so that up to the 1st of June they were met with of all sizes from the newly hatched to the winged. So long as provision sufficed for them on their hatching grounds they remained almost stationary, and created but little general apprehension, although many farms on bottom lands and fields adjacent to timber were overrun with them. As soon, however, as the supply of food in these situations was exhausted, they commenced to migrate, frequently in bodies a mile wide, devouring as they advanced all the grass, grain and garden truck in their path. The migrating propensity was in no instance, that came to my knowledge, developed till after the first molt. Up to that time they were content to huddle in warm places, and lived for the most part on weeds, and especially on the common dog fennel or mayweed (*Maruta.*)

The young locusts display gregarious instincts from the start, and congregate in immense numbers in warm and sunny places. They thus often blacken the sides of houses or the sides of hills—the prevailing tint of the mass during the first and second larval stages being a dull, deep gray. They remain thus huddled together during cold, damp weather. When not traveling, and when food is abundant, or during bad, rainy weather, they are fond of congregating on fences, buildings, trees, or anything removed from the moist ground. They

* See Köppen, "Ueber die Heuschrecken in Suedrussland," 1866, pp. 22-3.

also prefer to get into such positions to undergo their different molts.

Their power for injury increases with their growth. At first devouring the vegetation in particular fields and patches in the vicinity of their birth-places, they gradually widen the area of their devastation, until at last they devour every green thing over extensive districts. Whenever they have thus devastated a country they are forced to feed upon one another, and perish in immense numbers from debility and starvation. Whenever timber is accessible they collect in it, and after cleaning out the underbrush, feed upon the dead leaves and bark. A few succeed in climbing up into the rougher-barked trees, where they feed upon the foliage, and it is amusing to see with what avidity the famished individuals below scramble for any fallen leaf that the more fortunate mounted ones may chance to sever. This increase in destructiveness continues until the bulk of the locusts have undergone their larval molts and attained the *pupa* state. The *pupa*, being brighter colored, with more orange than the larva, the insects now look, as they congregate, like swarms of bees. From this time on they begin to decrease in numbers, though retaining their ravenous propensities. They die rapidly from disease and from the attacks of natural enemies, while a large number fall a prey, while in the helpless condition of molting, to the cannibalistic proclivities of their own kind. Those that acquire wings rise in the air during the warmer parts of the day and wend their way as far as the wind will permit toward their native home in the northwest. They mostly carry with them the germs of disease or are parasitized, and wherever they settle do comparatively little damage.

DIRECTIONS IN WHICH THE YOUNG LOCUSTS TRAVEL.

The young insects move, as a rule, during the warmer hours of the day only, feeding, if hungry, by the way, but generally marching in a given direction until toward evening. They travel in schools or armies, in no particular direction, but purely in search of food—the same school often pursuing a different course one day to that pursued the day previous. On this point the experience of last Spring is conclusive; and while the bulk of the testimony as to their actions, when hatching out in States further north and west, is to the effect that the prevailing direction taken is south or southeast, the *prevailing* direction taken last Spring, in Missouri, as gathered from the reports of numerous correspondents, was northward, sometimes a little to the east, at others to the west. I have, while traveling along a road, often seen them marching in one direction to the left and in the opposite direction to the right of me. They were more often noticed going against than with the wind, and, as they approached maturity, they seemed disposed to gather into more compact masses and prefer to advance in a northerly direction. The following extracts are given as illustrative of the experience of my correspondents:

There was no particular direction pursued by them; they went to one point of the compass as much as another, but when they moved, large bodies went in one direction. They traveled in columns from 4 to 40 rods wide, and fences and other obstacles frequently caused them to vary their course. The front of a column coming to an obstacle at right angles, (such as a fence or building) usually went through or over. But I have seen a column going southeast and another going southwest, come to an east and west fence, and then take their course along it in opposite directions, jumping over or against one another in an amusing manner. I opened the fence and set a wide plank on edge in the gap, that guided them through, and then from there they all took one direction south, many bushels passed through in a few hours.—[CALVIN A. MARK, Warrensburg, Johnson county.

They moved while yet unfledged in all directions, that is, different droves moved in different directions, and so persistent were they in their course, that they were seen to cross at right angles without becoming confused.—[G. W. ALLEN, Westport, Jackson county.

Although they move in nearly every direction at times, yet the whole movement was north.—[DAN. CARPENTER, Barry, Clay county.

There was no particular direction noticed, but they seemed to go against the wind to a great extent, but not always.—[J. W. MAPLE, Oregon, Holt county.

They were inclined to travel in a northwest direction, though they would go some little distance in other directions to get wheat and other things which they liked to eat. —[LEVI LONG, Island City, Gentry Co.

In this locality they traveled when unfledged, east and southeast. Living on the east of the Potawatomie creek, the young locusts which were hatched out near the timber had to travel in this direction to find food. On the west side of the creek they traveled west or northwest, for the same reason. On one occasion they were seen crossing each others track, traveling in different directions.—[JAMES HANWAY, Lane, Franklin Co., Kansas.

RATE AT WHICH THE YOUNG TRAVEL.

Having often watched the young insects on their travels and carefully timed them, I have concluded that when about half grown they seldom move at a greater rate than three yards a minute, even when at their greatest speed over a tolerably smooth and level road, and not halting to feed. They walk three-fourths this distance and hop the rest. Two consecutive hops are seldom taken, and any individual one may be run down and fatigued by obliging it to hop ten or twelve times without rest.

THEY REACHED BUT A FEW MILES EAST OF WHERE THEY HATCHED.

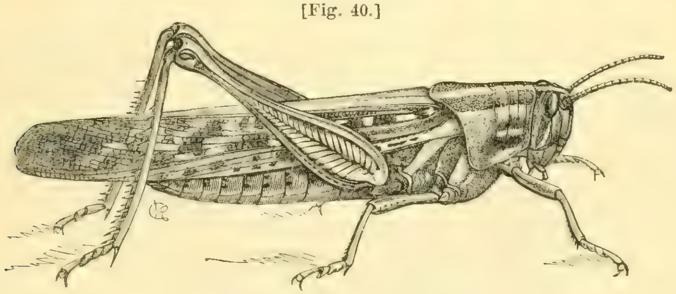
Rumors prevailed continually last Spring that the insects were spreading eastward and threatened to overrun the whole of the State, Illinois, etc. In reality, as I continually urged would be the case, they did not reach on an average five miles east of the limit line where they hatched. The reason is plain enough. At the rate at which they travel, as just described, they could not extend many miles, even if they continued to travel in one direction from the time of hatching till maturity. They travel only during the hotter portions of the day, say six hours on an average ; and their unfledged existence terminates in from six to eight, say seven weeks. It is very easy to calculate from these facts that if they continued in one direction from the time they hatch until they acquire wings, they would not extend thirty miles. In reality, however, they do not travel every day, and where food is abundant they scarcely travel at all. Moreover, as just shown, they do not commence traveling till after the first molt, and they do not go continually in a particularly eastern direction, but in all directions.

We have already seen that the winged insects took a northwest direction, and none flew to the east. Yet a few stragglers were carried as far as the centre of the State by being swept into the Missouri and drifted on logs and chips during the annual rise of that river in July; for I received specimens of the genuine *spretus* thus brought as far as Rocheport in Boone county, from Mr. Robert A. Caskie of that place.

NOT LED BY "KINGS" OR "QUEENS."

The idea that the young hoppers were led in their marches by so-called "kings" or "queens" was very prevalent last Spring. It is, however, quite unfounded. Certain large locusts belonging to the genera *Acridium* and *Œdipoda* hibernate in the full grown, winged

[Fig. 40.]

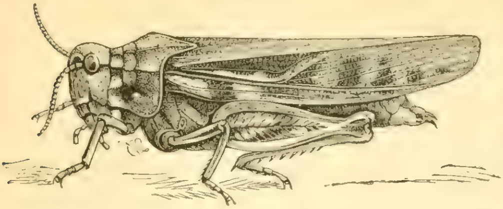


AMERICAN ACRIDIUM.

state, and not in the egg state, like the Rocky Mountain species. Always with us, their presence was simply more manifest last Spring, when the face of the earth was bare. Hopping with the others or falling into ditches with them, they gave rise to this false notion, and it is an interesting fact as showing how the same circumstances at times give rise to similar erroneous ideas in widely separate parts of the world, that the same idea prevails in parts of Europe and Asia.

The two species which are most often thus found with the young locusts and supposed from their size and conspicuity to be guides, are the American Acridium (*Acridium Americanum*, Drury, Fig. 40), and the Coral-winged Locust (*Œdipoda phœnicoptera* Germ., Fig. 41). The former is our largest and most elegant locust, the prevailing color being dark brown, with a broad, pale yellowish line along the middle of the back when the wings are closed. The rest of the body is marked with deep brown, verging to black, with pale reddish-brown, and with whitish, or greenish-yellow; the front wings being prettily mottled, the hind wings very faintly greenish with brown veins, and the hind shanks generally coral-red with black-tipped, white spines. The species is quite variable in color, size and marks, and several of the varieties have been described as distinct species. The Coral-winged Locust is also an elegant species, the colors being brown-black, brick-yellow inclining to brown, and a still paler, whitish-gray; the hind wings varying from vermillion-red to pink, with more or less yellowish-green, and with a broad external dusky border, broadest and palest at tip. The hind shanks are yellow with black-tipped spines. This species is also quite variable, and at least half a dozen of its slight variations have been seized upon to fabricate new species.

[Fig. 41.]



CORAL-WINGED LOCUST.

THE EXODUS IN 1875.

The grand exodus of the flying swarms from our borders began early in June, and reached its acme about the middle of the month. Some were leaving up to the last week in the month. The cheering news "they fly, they fly," was wired over the country from Coffeyville, Kansas, on the 29th of May, and a few days later these same words that cheered the waning spirit of General Wolfe as he saw that victory remained with England, and Canada was lost to France, passed along the lines from our Western counties, and gladdened the hearts and revived the dying hopes of the suffering farmers.

TIME OF LEAVING OF THE WINGED INSECTS.

The insects which hatched in Northern Texas and Indian Territory, began to leave on wing in greatest numbers, during the second and third weeks of May, and they doubtless went to make up the swarms which were reported as flying at intervals over Western Kansas and Nebraska, during the last half of that month. The grand hegira began, however, during the last two or three days of the month from Southern Kansas, where the insects were more numerous than farther south. By the 15th of June, they had nearly all left from as far north as Leavenworth. From the 7th of June on throughout the month, they were flying over Southwest Iowa and Nebraska, being most numerous, judging from the balance of the many reports collected, about the middle of the month. A little later the bulk of them was flying over Dakota, and they are reported as flying most numerously in Montana during the month of July. The following memoranda from two of my correspondents, show how almost continuously during the first three weeks in June, they were observed passing over the northwestern portion of our own State:

From my diary, I find that they commenced rising up and leaving for the first time on the 31st day of May; flight, northwest. June 1st, course north. June 2d, northeast at noon; at 3 P. M., course west; 3d, northeast; 4th, rain prevented any from leaving; 5th, cloudy, none flying; 6th, flying northeast at noon; at 3 P. M., course west. June 7th, noon to 1 P. M., southwest; 3 P. M., flying west, with wind from northwest, and seemed confused; and while they could not stem the current of wind to make their desired course, they were shifting to new quarters in search of food. June 8th, leaving in large numbers, course northeast. June 9th, heavy rain the past night—hoppers doing heavy damage to our orchards; noon to 1 P. M., flying confusedly, but generally bearing to the northeast. June 10th, attempting to fly northeast, but heavy winds will not admit of their leaving. June 11th, flying northeast, nearly east. June 12th, flying west upper current, but an under-current of wind caused multiplied millions to come down, covering the whole face of the earth. June 13th, 9 o'clock A. M, commenced flying northwest till 11, when the wind shifted to the northeast, great numbers came down, and did great damage to our trees. June 14th, flight northeast. June 15th, but few leaving. June 16th, course northeast. June 17th, flying north in vast numbers. June 18th, cloudy; but few flying. June 19th, flight northeast; immense swarms of them. June 20th, flight northeast, in vast numbers. June 21st, hoppers thinning out; a few flying at 1 P. M. June 22d, flying in considerable numbers to the northeast. June 23d, flying but little, and we commenced replanting our corn and garden.—[Z. S. RAGAN, Independence, Jackson Co.

To give you some idea of the locust plague, let me describe briefly their flight. Eleven days ago they began to pass here overhead. They begin to rise up about 9 o'clock, and by 10 o'clock they are nearly all on the wing. They go as the wind drives them. Excepting one day, when we had a wind from the north, their flight has been from the south northerly. Looking up, at any time between the hours of 10 and 4, towards the sun, they may be seen passing like large snow flakes, rapidly as their wings and the wind can make them. By a large spy-glass I judge the swarm to be about half a mile deep. And so they go, day after day. By night they settle down. On the evening of the day before yesterday, we concluded the swarms were about exhausted, as not nearly so many had passed during that afternoon, and we congratulated ourselves on possible future exemption. But yesterday the air was again full of them; and last evening about six miles north of this, they came down in a line extending all across the country in such tremendous clouds as to frighten people. Many persons that were out ran in-doors, fearing lest they might be smothered. A gentleman, Judge Russell, who was riding along, said that for some time he regarded it as a vast storm-cloud coming down over the whole land, and the sound was said by one to resemble that made by a locomotive and long train of cars. Now, to-day, with a southeast wind, the air is again filled with them, flying to the northwest.—[CLARKE IRVINE, Oregon, Holt Co., June 18.

DIRECTION TAKEN BY THE WINGED INSECTS.

From the facts recorded in considering the last Spring's history of the plague by States, and particularly by the observations so kindly obtained for me from the Territories by General Myer, Chief of the Signal Bureau, it is evident that the main direction taken by the insects that rose from the lower Missouri Valley country was northwesterly: in other words, toward what I believe to be the native home of the species, whence their parents had come in 1874. That they instinctively sought this direction there can, I think, be no doubt; for while they depend in great part on the wind for propulsion, and without its aid would be unable to migrate to very great distances, I have a large number of reports to show that whenever the wind blew from the north or northwest, the locusts came down and waited a change to a more favorable direction. They begin to rise when the dew has evaporated, and descend again toward evening. A swarm passing over a country yet infested with the mature insects, constantly receives accretions from these, and is, consequently, always more dense in the afternoon than in the forenoon. In rising, the insects generally face the wind, and it is doubtful if they could ascend to any great height without doing so. They are, I believe, good navigators, and know how to take advantage of the different air currents. The rate at which they travel will depend on the force of the wind; but it is evident from the observations made in Dakota, where their advance was reported by telegraph, (*ante* p. 37,) that last Spring they often traveled a hundred miles a day. Their minimum speed, in tolerably calm weather, when the wind is scarcely felt at the surface of the ground cannot be much less than from eight to ten miles an hour.

The exceptions to the northwest course occurred toward the end of the first week in July, when swarms were seen flying southeast over northeastern Kansas. These could hardly have originated in the adjacent parts of Iowa or Missouri, as the bulk of the insects had by that time left that section; they were probably detachments of the swarms that left Minnesota about the first of the month and which, as their parents came from the southeast in 1874, instinctively flew in that direction. During July they also flew south from their native hatching grounds in Colorado; while later in the season, viz. in August, fresh swarms from the northwest and west flew over that State in a southeast direction.

DESTINATION OF THE DEPARTING SWARMS.

That the swarms which left the fertile country in which they hatched and are not indigenous—say all the infested region lying south of the 44th parallel and east of the 100th meridian—passed by degrees to the northwest and reached into northwest Dakota, Wyoming and Montana, the records clearly prove. Whether or not they reached up into British America, I have no means of judging. I believe, however, that few, if any, did. Those which survived long enough to deposit eggs evidently reached the higher and treeless regions north and west of the region just indicated; but that a large proportion of those which took wing perished on the way from debility, the effects of storms, and more particularly the attacks of parasites, there can be little doubt; because I proved by careful dissection that a large proportion of those which came to maturity and left our own western counties, carried with them the germs of destruction in the shape of *Tachina* eggs or the larvæ already hatched and of various sizes. Others again were infested with the scarlet mites. As some persons have expressed doubts as to whether these locusts are ever killed by the parasites I described last year, I will state that before the insects began to leave Missouri last Spring large numbers had actually died of these parasites, and that on five different occasions in five different localities, a hundred of the winged specimens taken at random showed 5, 8, 10, 23 and 52 per cent. infested with Tachina larvæ alone, to say nothing of mites. The following items in addition to what is recorded on preceding pages, will show how very generally over the country vacated by the locusts, this parasitism occurred:

FORT SCOTT, Kas., June 1.—Messrs. Durkee and Stout, extensive and successful farmers near this city, report that they have caught in a sheet and killed some six or seven bushels of grasshoppers or Rocky Mountain locusts. They have examined large numbers of them by dissection and close inspection, and find that about nine out of every twelve so examined contain a well developed maggot, alive, and differing in size and development. These they feel sure after a thorough examination, will eventually kill and exterminate the entire grasshopper tribe in this country in a very short time. In proof of the existence of this maggot found inside, Messrs Durkee and Stout state that the large piles of grasshoppers which they have killed are almost immediately alive with the maggots.

Mr. Young, another large farmer, reports to-day that they are leaving in the last few days, flying away high in the air in large numbers. All of these, however, it is thought, contain the parasite or maggot above spoken of, and will never be able to do any further damage. It is thought that the season of the year has come when we can anticipate no further damage, and we do not any more in this section.—[From a dispatch to the Kansas City *Times*.

The general Government should appoint a Commission to study the habits of the locusts, ascertaining where they come from, and where they have gone, and obtain full information concerning them. It is known that all leaving this country were covered with parasites, and it is believed that these parasites destroy them, but there is a very general feeling that too little is known of the pests, and it is the duty of the Government to appoint a competent Commission for the study of their habits. Senator Ingalls has telegraphed to the Secretary of War, asking him to direct military and signal officers throughout the Northwest to observe and report their movements.—[Correspondence to the Chicago *Tribune*, from Atchison, Kans , June 16.

It is reported that some kind of insect has destroyed the grasshoppers in Bourbon county, as they lay dead in heaps on the roadside. It is said they are dying everywhere in the southern part of the State. A farmer from Jefferson county says that some kind of an insect or parasite is destroying them by the thousands in his locality. Another farmer reports the same in his locality; and that handsful of dead grasshoppers can be gathered. We are having continued rain-falls, and it is said the wet weather is favorable to the destruction of these pests. A gentleman, just returned from a tour through Jackson, Cass and Bates counties, Missouri, says the grasshoppers are much more numerous in that section than in this.—[Chicago *Tribune* correspondence from Atchison, Kans., May 18.

Reports from the grasshopper districts Friday are more encouraging. They are leaving as fast as they get wings, and parasites are making sad havoc in their ranks. When a column of them take flight many are observed to fall to the ground unable to fly. An examination invariably shows that they have been so enfeebled by maggots that they are unable to get away and soon die.—[Jefferson City *Tribune*, June 9.

There are a few people who yet refuse to believe that parasites are destroying the locusts. Hundreds of the most intelligent and practical men in the State have carefully studied this question, and all agree, so far as we have heard, that not one locust in a thousand will live long enough to reach his native country in the northwest. Ninety-nine out of every hundred of these pests are covered with parasites. We recently examined a grasshopper with a powerful microscope, and counted twenty-four parasites upon it. Upon nearly every hopper that can be found will be found from two to a dozen of these parasites, ranging in size from a minute atom, hardly visible to the naked eye, to the proportions of a pin-head.

Experienced entomologists, and careful, observant, practical men of all classes, have devoted great attention to the study of these parasites. And their investigations conclusively prove that, so far as the grasshoppers visiting this region are concerned, their race is run. They are dying by millions. Those that live to get back to their native haunts cannot propagate their species. Nature, always faithful in adjusting its balances, has provided an enemy capable of mastering the grasshopper, and this enemy is the little red parasite that can be found either on his wings or his body.—[Atchison (Kans.) *Champion;* forepart of June.

Thousands of grasshoppers fell to the ground in the Republican Valley and elsewhere, while flying, and all seemed to be destroyed by parasites, eating into the body at the base of the wings. Within the last few days I have examined many localities in the vicinity of Lincoln, where the grasshoppers have appeared, and in five spots found the ground covered with their dead bodies, which, on examination with the microscope, were seen to be literally devoured by these minute parasites. I hear the same thing reported from different parts of the State. — [Correspondence of the Lincoln (Nebr.) *Journal*, about the middle of June.

Mr. Al. Dunbar brought to our office this morning a handful of healthy looking locusts, and requested us to inspect them. We did so, and pronounced them a fair article. He then dissected them, one by one—by pulling them apart just below the head — and in the upper part of the body of six out of eight locusts, a white worm about one fourth of an inch long, was discovered. The balance might have been infested also, but not having a microscope we could not tell. Other persons have discovered these worms, and report that the locusts are dying rapidly. The worms are hatched from an egg deposited beneath the leg or wing by an insect similar to a common house-fly.—[Warrensburg (Mo.) *News*, June 2.

From this experience we may very justly conclude that a large proportion of the insects which departed from the country invaded in 1874, perished on their way toward the native habitat of the species, and that those which did not so perish reached the Rocky Mountain region of the northwest whence their parents had come the previous year. They struggled back with thinned and weakened ranks, and it will probably take many years ere they become so prodigiously multiplied again, and are enabled by favorable conditions to push so far east as they did in the year 1874. They did some harm at their resting places on the way, but in a large number of instances, they rose after their brief halts, without doing serious injury. Nor can I learn of any instances where these swarms that left our territory deposited eggs. Had the winds been adverse to their northwestern course, and obliged them to remain in the country where they hatched, I believe that the bulk, if not all of them, would nevertheless have perished before laying eggs.

NATIVE HOME OF THE SPECIES.

The question as to the native home of the species will always interest. Having carefully weighed all that has been written on the subject during the year, and eagerly sought all information that might shed light upon it, I am firmly convinced of the general truth of the views enunciated under this head in my last Report. The species is, in fact, "at home in the higher altitudes of Utah, Idaho, Colorado, Wyoming, Montana, northwest Dakota and British America. It breeds in all this region, but particularly on the vast hot and dry plains and plateaus of the last named Territories, and on the plains west of the Mountains." In that country alone does it come to perfection for a series of years, and in that country alone can it become so prodigiously multiplied, and be borne by the wind to such distances as to overrun the country already indicated (p. 106) where it is not indigenous, and reach as far east as it did in 1874. To this end, also, a combination of favorable conditions that only occasionally occur, are necessary. The best evidence of the soundness of a theory is its power of absorbing newly ascertained facts and of overcoming objections that are raised against it. The facts already adduced as to the direction and destination of the departing swarms from the lower Missouri and Arkansas river country add strength to the theory. I will here briefly notice the principal objections to it, made by Mr. S. H. Scudder, as a means of adding to the arguments already brought forward. In the Proceedings of the Cambridge Entomological Club for June 11, 1875, as reported in *Psyche* (the organ of the club), for Febr. 1876 (Vol. 1, p. 144) occurs the following:

> Mr. Scudder offered some remarks on Mr. Riley's account of *Caloptenus spretus* in his recent Annual Report. The speaker doubted whether these insects took flight from the heart of the Rocky Mountains [1] to the localities in which they were destructive, passing over the wide expanse of arid plains which intervene, because there has been no record of their occurrence in swarms in these plains, and there is sufficient ground for the supposition that they may have developed in the immediate vicinity of the regions which they devastate [2]. It is well known that among other insects there are years in which individuals are suddenly very abundant, and intervening series of years in which few are to be found. It is also known that a few of these locusts can be found in Kansas and Missouri, and in fact from Texas to Manitoba every year, [3] so it seems hardly necessary to look so far for the derivation of the destructive swarms. Moreover, the circumstance, mentioned by Mr. Riley, that the locusts get tired after repeated flights, is an additional argument against the supposition that they came from a great distance, for the rate at which their strength diminished seemed out of all proportion to the activity of the insects at the time of their first ravages. [4.]

[1] I have nowhere spoken of the "heart of the Rocky Mountains" as the source of the swarms that take their flight to our country. On the contrary, my language is very different (*vide* Rep. 7, p. 163), and it is upon this kind of misapprehension that Mr. Scudder's remarks are based.

[2] It is difficult to comprehend what is meant here, since I have myself shown that much of the country devastated must be in the immediate vicinity of the hot, dry plains and plateaus in which I believe the species is more particularly at home. I have also expressed my belief that the swarms that occasionally, during Summer, devastate the country in which the species is not indigenous, must necessarily be the progeny of insects developed at no great distance from the sections they invade, whether they come from Minnesota southward; from Colorado eastward, or from Texas northward; and I endeavored to draw the distinction in 1874 between these Summer swarms and the more disastrous Falls warms. On this point the Minnesota Commission remarks (Special Rep. to Gov. Davis, p. 25):

It is plain that locusts hatched in Colorado and regions to the south and southwest of Minnesota acquire wings in time to allow them to reach this State in the former half of June. This is shown by the time when the invasion occurred in 1873, and by the immense flights of locusts which passed over Nebraska and Dakota to the northward in June, 1875. It seems to be a common impression that the locusts which have invaded Minnesota at other times were hatched in Montana, northwestern Dakota and British America, and this is rendered probable by what few facts we know, and by the time and direction from which they came. These attacks are all represented as coming from the west, north or northwest, and reached the Red River Settlement in the last week of July, 1818, the Upper Mississippi about the same time in 1856, the western line of the State in the former half of July, 1864, and on July 15th, 1874. In the last three cases the invasions did not reach their farthest limit until a considerable portion of the crops had been harvested.

If Mr. Scudder means that the hordes that occasionally overrun in August and September the whole territory which I have indicated as outside the insect's natural habitat, originate within or upon the borders of that Territory—the country south of the 44th parallel and east of the 100th meridian—then the facts are entirely against his supposition. The late swarms of 1874 are known to have traveled from five to six hundred miles after having reached the more thickly settled country and been observed. The period that elapses between the acquiring of wings and the deposition of eggs is not positively known. From analogy and from a general survey of the facts at hand, I have placed it at from two to three weeks. The Minnesota Commission, in their Special Report to Governor Davis, state (p. 26) that it has been known to be as short as eight days. I think we may safely say, judging from the insects that have hatched out and laid in the same regions in Minnesota, that it will be within a month. Now, the late deposition of eggs—as in September and October, in the region that suffered so last Spring—implies late hatching and development of the parents; and the insects that laid in our western counties, in 1874, must have hatched as late as June 1st, and this late hatching could only occur in the higher sub-alpine regions of the northwest. Of course, in speaking of the hatching of the species, I do not forget its irregularity in the same locality, and refer in consequence to the bulk of the eggs. The invasion of northern regions, like Minnesota and Dakota, from the still further northwest, makes it also clear that the insects come from beyond. The theory of short flights and development, in the immediate vicinity of the country devastated, will scarcely answer for the late disastrous and general irruptions like those of 1866 and 1874; and in discussing this question the difference between these irruptions and the earlier, more frequent and less disastrous ones, should always be borne in mind.

[3] I deny that the species, as defined in these reports, and as it swoops down from the mountain region, occurs every year in Missouri, Texas, Kansas, or any of the country to which I have indicated it is not indigenous. It occurs there only as the dwindling progeny of the swarms from the west or northwest, and never becomes acclimated. I have traveled through Iowa, and from Omaha to Denver, collecting plants and capturing insects along the route on every occasion; I have traveled extensively in Kansas, Indian Territory and Texas, always collecting; I have been overwhelmed in the latter State with swarms of locusts while in front of an engine, and yet, among all the locusts collected, I have never found the genuine *spretus*. It cannot be found there any more than it can be found in our western counties, except as the progeny of invading swarms. There is no instance on record of the species, when hatching out in any of this country, remaining long enough to lay eggs, even supposing it capable of doing so under such circumstances. We find it multiplying continuously west and north of the boundary indicated; pushing annually, in detachments, eastward from the mountains to the west, and southeastward from the country to the northwest; but only at long intervals does it sweep down in countless myriads and extended and devastating swarms from the extreme northwest. Just beyond the confines of the country in which it permanently multiplies, it follows that it will more often do injury than farther east and south; it will also hold its own longer, but sooner or later it vanishes from the country beyond those confines. It either vacates the territory on the wing or is destroyed by influences adverse to its well-being.

In placing these confines along the 44th parallel and 100th meridian, I think I have given the utmost southern and eastern limit. Prof. Thomas indicates the eastern boundary as along the 103rd meridian, while Mr. G. M. Dawson, in the pamphlet already referred to, says that "north of the 49th parallel, the whole area of the third or highest prairie-plateau, and probably much of the second, are congenial breeding places, and here the locusts are always in greater or less numbers." Regarding the western boundary, nothing struck Prof. Thomas* as more singular than the few specimens of *spretus* collected west of the mountain range by the Hayden Geological Survey, from which he infers that the line of the survey was along the southwest border of its district. Mr. J. D. Putnam, of Davenport, Iowa, who spent July, August and September of last Summer in Utah, also informs me that he did not meet with a single specimen.

This whole subject of the original source of the swarms that at times lay our fertile valley country under such severe contribution is yet somewhat obscure, and should be investigated by the Government. Meanwhile we must shape our views by the facts in our possession.

[4.] Now that we know where the bulk of the eggs were laid, it seems more than likely that the principal reason of the retarded progress of the 1874 swarms, by the time they reached east Kansas and Missouri was due to the fact that they were more busily engaged in ovipositing than they had previously been. Moreover they there strike a country more or less timbered, with moister atmosphere, and less violent and more changeable winds.

CONDITIONS OF MIGRATION.

The exodus from the country where the species is not indigenous would seem to be instinctive and determined perhaps by the injurious effects of the uncongenial climate. The cause of the migrations from its native northwest home I discussed in my last Report (p. 164). Hunger and strong winds are the principal; but the conditions which permit extended flights and migrations southeast are doubtless, in great part, meteorological, and as throwing light on these conditions, the following from an interesting review of the locust question by Mr. W. H. Miller, and published in the Kansas City *Journal of Commerce*, will prove suggestive:

> Since it has been well ascertained that dry weather is a necessity to its prosperous existence, it is concluded that dry seasons are necessary to its invasions. There is much force in this conclusion, for since the moisture of the western States and Territories is borne to them from the Gulf of Mexico by southerly winds, a dry season indicates a diminishing of these winds, which removes two important impediments in its advance—moisture and opposing currents of air. It is also held by entomologists that it migrates only when the vegetation of its habitat becomes exhausted. A diminished southerly wind, and a dry season on our western plains, would favor this result, for since the moisture of this region comes from the Gulf, a dry season on the plains and short vegetation there would indicate a dry season and short vegetation in the latitude where we have supposed its habitat to be.

* Preface to his Report upon the Collections of Orthoptera made in Nevada, Utah, California, Colorado, New Mexico, and Arizona, in 1871, 1872, 1873 and 1874, by Hayden's Geol. Surv. of the Terr. (1876).

THE CONDITIONS WHICH PREVENT THE PERMANENT SETTLEMENT OF THE SPECIES IN MISSOURI.

The conditions which determine the geographical limits in which a species can exist, are often complex, and it is not generally easy to say precisely what they are. Assuming that I have correctly placed the native home of the species in the higher, treeless and uninhabitable plains of the Rocky Mountain region of the northwest, and that it is sub-alpine,we may perhaps find, in addition to the comparatively sudden change from an attenuated and dry to a more dense and humid atmosphere, another tangible barrier to its permanent multiplication in the more fertile country to the southeast, in the lengthened Summer season. As with annual plants, so with insects (like this locust) which produce but one generation annually and whose active existence is bounded by the Spring and Autumn frosts—the duration of active life is proportioned to the length of the growing season. Hatching late and developing quickly in its native haunts, our Rocky Mountain Locust when born within our borders (and the same will apply in degree to all the country where it is not autochtonous), is in the condition of an annual northern plant sown in more southern climes; and just as this, attains precocious maturity and deteriorates for want of Autumn's ripening influences, so our locust must deteriorate under such circumstances. If those which acquired wings in Missouri early last June had staid with us long enough to lay eggs, even supposing them capable of doing so, these eggs would have inevitably hatched prematurely and the progeny must in consequence have perished.

Being a firm believer in change by modification in what we call species, and that climatic conditions play a most important part in causing this change, and that they act more rapidly than most evolutionists grant, the idea has been very strong in my mind that the species might become profoundly modified in the direction of *Atlanis* in the course of two or three generations in the country to the southeast, and that in this way and through miscegenation with our native species, its extinction from our territory might also be accounted for. It has also been suggested by Prof.Thomas—a professed anti-Darwinian—in an elaborate paper published last October in the Chicago *Inter-Ocean*, and, as bearing on this point, I will state that the specimens which hatched in and left our western counties last Spring were, on an average, somewhat darker and smaller than their parents. But after fully digesting all the facts, I am convinced that these influences play a very unimportant part, if any; and that they cannot be considered as factors in the problem. All that could get away from the regions of Missouri, Kansas, Iowa and Nebraska ravaged last Spring, did so; and if I may judge from experience in our own State, those that could not, perished, so that not a remnant of the army was left in the Fall.

But whatever the causes, the fact of debility, disease and deterioration in, as well as migration from, the more fertile southeastern country the species occasionally devastates, stands forth clearly and cannot be gainsaid. The following observations from careful observers may be placed on record here:

Mr. Riley is of the opinion that the grasshoppers run out in a few generations after they leave their native sandy and gravelly soil. My experiments so far as they go, verify that opinion. For several years I have caught grasshoppers during early summer that came fresh from the direction of the mountains, and by attaching their legs with fine silk threads to a small spring balance, found that their physical strength was from twenty-five to fifty per cent. greater than that of grasshoppers treated the same way that were hatched in Nebraska or in States further eastward or northward. The same result was reached by caging them, and ascertaining how long they would live without food, and also by vivisection. In some places, also, the eggs that were laid in different years since 1864 did not hatch out. The changes from extreme wet to dry, and from cold to hot weather, or some other unknown causes, seems to sap their constitutional vigor. Were it not for this, long ere now these grasshoppers would, from their enormous numbers, have desolated the whole country as far east as the Atlantic. --[Prof. Samuel Aughey, of the University of Nebraska, in the Lincoln (Nebr.) *Journal*.

I have observed hundreds of winged locusts fall to the ground during flight, either already dead or soon dying. These upon examination have generally proved to contain no parasites, and I judge that their death was in consequence of impaired strength, this second generation raised in an unnatural climate not equalling in vitality the first generation and succumbing to the fatigue consequent upon extended flight.—[Prof. F. H. Snow, of Kansas State University, in *Observer of Nature*.

DEFINITION OF THE SPECIES.

In defining the Rocky Mountain Locust last year, I endeavored to show that we have three closely related forms or so-called species, viz.: *spretus*, which is the devastating species of the West; *femur-rubrum*, a somewhat smaller, shorter-winged species common over the whole country, and *Atlanis*, a still smaller species, but, except in size, approaching in general character nearer to *spretus* than *femur-rubrum*. Careful study of the subject has convinced me of the correctness of the definitions then given. In the report of the meeting of the Cambridge Entomological Club, already referred to, we are told that:

Mr. Scudder also doubted the specific and perhaps even the varietal rights of *C. Atlanis*, described by Mr. Riley from the White Mountains, for specimens of *C. spretus* have been found in different eastern localities, and, like many other insects of wide latitudinal distribution, have shorter wings than the western forms. Mr. Riley gives no characters of importance to distinguish *C. Atlanis* from *C. spretus*.

An opinion like this from one who has given much attention to the Orthoptera might command respect were it not unjust and superficial. All discussion at the present day as to whether we are dealing with species or varieties, is more or less puerile. Naturalists have no fixed standard as to what constitutes a species, and are fast coming to the conviction that there is no such thing in nature, and that the term is conventional—an abstract conception. Yet it is the custom, in entomology and botany more particularly, to separate by names, under this term species, forms that are separable and show constant differences; and the separation of such by the study of large material, and their life-histories is of far more weight and value than that by the examination and description, however detailed, of one or two individuals. In giving my opinion that "the future orthopterist, as he studies material from all parts of the country, will very likely write: *Caloptenus femur-rubrum*, DeGeer., var. *spretus* Thomas, var. *Atlanis* Riley; but the broad fact will remain that these three forms —call them races, varieties, species, or what we will—are separable, and that they each have their own peculiar habits and destiny," (Rep. 7, p. 171,) I have, I think, indicated how very immaterial it is what rank in a system of classification they hold; but nothing is more certain than that typical specimens of each are at once distinguishable, and far more readily than the majority of species described in Entomology—and, let me add, than many of the species described by Mr. Scudder himself in the same Family and genus. If I should say that my friend "gives no characters of importance to distinguish" many of his species, I might be deemed rash; the following opinion, therefore, of Prof. Thomas, which I am permitted to publish, will have more weight. Prof. T. writes me: "Although the descriptions of species established by Scudder may be ample and sufficient in other orders; in *Acridii* I have, as a general rule, found them quite unsatisfactory. The characters chosen are those most liable to variation, and hence insufficient in describing species. As a natural consequence, a number of his species are in fact but varieties." As Prof. Thomas himself has confessedly, in his Synopsis of the Acrididæ, described several varieties as species,* it would seem that even if Mr. Scudder's opinion of *Atlanis* were just, I should simply be in the same boat with himself and the other authorities. Not to waste words, however, on what

* I am fully convinced that this has occurred even more often than he imagines; for unfortunately he rarely states the number of specimens described from, and although he relies more on structural than colorational characters as of more value and less variable, even they lose their value if founded on slight variation, when large material is examined. During the past year I have collected very largely of the commoner species in this Family, and I unhesitatingly assert that, with few exceptions, minute relative measurements of parts or minute colorational descriptions from a few individuals are of little value; and that in Calopteni particularly, specimens taken from the same locality show such variation, and so connect with other species through these variations, that there is no proper way of defining except by the average differences of large numbers. Not only would many supposed species vanish by this method, but many genera also; for I have good evidence to show that in several cases, species described under the genus *Pesotettix*, are but short-winged forms of *Calopteni*. In submitting some material for determination to Prof. Thomas, he writes: "You have assigned me a very difficult task in submitting to me for determination these erratic Caloptenoid forms. * * Stal's attempt to systematize, if carried out will give us a genus for nearly every species; and Scudder seems disposed to make a distinct species for each variation in color."

must remain a matter of individual opinion, I repeat that careful comparisons made during the year of many hundreds of specimens both living and dead, of *spretus*, *femur-rubrum*, and *Atlanis* fully establish in my own mind the justness of the separation of these three forms, and Prof. Thomas is of the same opinion. I have a box full of each now before me, and no one would for a moment hesitate to separate the typical, diminutive, livid, mottled and strongly marked *Atlanis* from the typical, large, pale, more uniform and voracious-looking *spretus*. Granted—as I freely have—that they approach each other through deviations from the average, as indeed most species do, I have yet to see the first specimen of *spretus* and *Atlanis* that I could not properly separate; and when Mr. Scudder is more familiar with the true Rocky Mountain *spretus*, he will give up his notion that it occurs in different localities in the East. All such statements result from confounding these two forms and the inaccuracy that such statements imply is good evidence of the necessity of designating the two forms by different names. Indeed *Atlanis* is more effectually separated from *spretus* than from *femur-rubrum*, for while it may be distinguished from this last by the characters which I gave a year ago, viz.: smaller size, more mottled coloring, relatively longer wings, and notched anus; and while aside from these characters, its brighter yellow venter permits its separation with great ease in life, the two forms more thoroughly blend by departures from the average, than do *spretus* and *Atlanis*. Thus, Mr. Thomas in speaking of them, writes:

So far all the *Atlanis* I have spread have the wings slightly tinged with blue when fresh, while this does not appear to be the case with the true *femur-rubrum;* it (*Atlanis*) also has the outer face of the posterior thighs more distinctly marked with alternate oblique dark and light bands, in these two characters agreeing very closely with my *C. occidentalis*, which is probably but a variety of *femur-rubrum*, as I am compelled also to think your *Atlanis* is. I might add also that I believe *Atlanis* usually has the hind tibiæ blueish, but this character is so uncertain that it is of little value.

I am inclined to think *femur-rubrum* the older form and that during the change which produced the desert condition of the west it was converted in that district into *spretus*. The *Atlanis* form I think is less permanent and more transient, the result probably of suitable climatic conditions continued but a few years, and that as soon as the climate returns to the normal condition it will revert to the usual form of *femur-rubrum*. My *C. occidentalis* belongs chiefly to that region and climate found in Northwestern Minnesota and Eastern Dakota.

Not having previously taken specimens of *Atlanis* in Missouri, I formerly inferred that it was confined to the mountain regions of the Atlantic. In 1875 I collected it in large numbers in St. Louis, Jefferson, Washington, St. Charles, Warren, Franklin, Boone and Cole counties in Missouri, and in various parts of Illinois. I found it associated with *femur-rubrum*, and often in equal numbers; and this in two instances in the same fields in which the year before I had collected hundreds of specimens of nothing but *femur-rubrum*.

In this connection I will also record the occurrence of a variety of *spretus*, in which all the pale or normally yellowish-gray parts are bright green. These green individuals are conspicuous among their brown brethren. I found them to constitute about one in a thousand of the schools around Warrensburg, and singularly enough nowhere else. The green endures from the larva to the perfect state, and I would designate this variety as *viridis*. It is but a marked colorational variety, in a species which has not heretofore been known to present these colorational differences, and no one having a true conception of the differences between *spretus* and *Atlanis* would think of placing the latter on the same grade.

Comparisons of the immature stages of these three species show that, when large material is examined, *femur-rubrum* and *Atlanis* are more nearly allied than this last and *spretus*, though, as in the mature insects, they approach each other through exceptional individuals.

In the first stage, *spretus* has a decidedly ferocious look, the head being out of all proportion to the rest of the body. The colors are brown, gray and dull white, the general tint being light gray, and the insect presenting a mottled and speckled appearance. The antennæ have several joints less than when mature, and are more thick and clavate. The frontal ridge is more prominent and deeply sulcate. The cerci extend beyond the rounded tip of the abdomen. The tarsi show the three joints, but the middle one less distinctly than afterwards. The medio-dorsum from vertex to near the tip of the abdomen, is carinate and pale. Of the dark dots and marks the most conspicuous and persistent (for some specimens are much darker than others) are, one behind the eyes, a sub-quadrate one on the side of the meta-thorax, a crescent streak on the sides of the swollen end of hind femora, and two spots on the bulbous base of hind tebiæ. In the second stage the face with very rare exceptions is pitchy black, the top of the head shows the three characteristic rows of transverse black marks on a rust-brown ground, the outer rows curving around the eyes, and the middle one broadest and divided by a narrow medial, pale line; the rust-brown color continues, with more irregular black marks on the prothorax, narrowing toward its middle; on each side of it the anterior part of the prothorax is black, relieved below by a conspicuous, arched pale line, and this again with a more or less distinct dark lateral mark beneath. The cheeks are mottled with rust-brown and edged behind with yellow; the head beneath, and palpi, except a black rim around tips are pale yellowish. The other colors are much as in the mature insects. With each succeeding stage the broad and pale streaks of prothorax intensify, and as soon as the hind wing-pads are turned up over the front pair, viz: in the third stage, the pale spot at the base which becomes so conspicuous in the pupa, is visible. The black face after the first molt is quite characteristic, and often endures to the pupa state.

Atlanis, in the first stage, is distinguished by its deeper, more livid, or rosy, less speckled appearance, and more strongly contrasting brighter yellow venter. In the subsequent stages these colorational differences still prevail and the face is not black as in *spretus*; the pale spot on the hind wing-pads is less conspicuous in the third, and the pupa is not only distinguished by its smaller size and different color, but by the narrower, more obsolete black marks of the prothorax and by the wing-pads being considerably shorter and smaller, the hind pair livid, with only rarely a touch of black at base, and with the pale spot obsolete. It presents in fact a marked contrast to the pupa of *spretus*. In the early stages, *femur-rubrum* is distinguished from *Atlanis* by no very constant characters, except the generally paler, less livid and greener hue.

As the idea prevails among many of our farmers that our Rocky Mountain Locust is identical with the devastating species of the Old World, and Mr. Z. S. Ragan, in an otherwise excellent essay, read at the last meeting of our State Horticultural Society, gives it as his opinion that our locusts "came over from Asia via Behring's Strait, to British America, thence extended from time to time over Washington Territory, Oregon, California, Utah, Idaho, Montana, Wyoming, Dakota, Nevada, Colorado, Arizona, New Mexico, Texas, Kansas, Indian Territory, Nebraska, part of Missouri, Iowa, Minnesota and Wisconsin;" it may be well to insist here that there is no foundation whatever for such an opinion, and that *spretus* is a purely American species, occurring in no part of Europe or Asia.

EXPERIENCE IN THE SPRING.

Having already spoken of the desolate aspect which the ravaged country wore toward the end of June, it will suffice in this connection to give a few of the more interesting experiences. It is recorded in Europe that few things, not even water, stop the armies of the young locusts when on the march, and Döngingk relates having seen them swim over the Dnjestr for a stretch of 1¼ German miles, and in layers 7 or 8 inches thick.* We have had similar experience with our own species. Mr. James Hanway, of Lane, Kansas, informs me that the young last Spring crossed the Potawotomie Creek, which is about four rods wide, by millions; while Mr. Z. S. Ragan, of Independence, told me that the Big and Little Blues, tributaries of the Missouri, one emptying into it above and the other below his place, the one about one hundred feet wide at its mouth, and the other not so wide, were crossed at numerous places by the moving armies, which would march down to the water's edge, and commence jumping in, one upon another, till they would pontoon the stream, so as to effect a crossing.

A neighbor also informed him that two of these mighty armies met, one moving east and the other west, opposite his farm, on the river bluff, and each turning their course north, and down the bluff, and coming to a perpendicular ledge of rock twenty-five or thirty feet high, passed over in a sheet, apparently six or seven inches thick, and causing a roaring noise similar to a cataract of water.

* Köppen, *loc. cit.*, p. 43.

It was generally supposed that evergreens would escape the ravages of the young insects, but wherever these were abundant, hemlock, arbor vitæ, the different pines, and especially the Norway spruce, for which they showed a predilection, were stripped. The red cedar more often escaped. Wild prairie, especially that which was low, would be eaten down less closely than other grasses, and oats more often escaped than other cereals. Blue grass was sometimes killed out, but more generally not, and corn was eaten down so often and so deeply into the ground that it was frequently destroyed. Potatoes were not killed by being eaten down and very generally made a crop after the insects left, without replanting. This was especially the case where planted deep and where the vines as they grew were at first kept covered with earth, which they can be with impunity. The blossoms and stems of peas were left after the leaves were stripped, and parsnips sometimes remained untouched. All other vegetables were swept off. Of wild plants, Milkweed (*Asclepias*) and Dogbane (*Apocynum*) were little to their taste, and only taken when all else was destroyed; an occasional *Salvia trichostemmoides* and *Vernonia novæboracensis* would also be left in the general ruin; but the plant of all others that enjoyed immunity from the omnivorous creatures was the *Amarantus Blitum*, a low, creeping glossy-leaved herb, lately introduced into the State. I found this plant unmolested even where the insects were so hard pushed for food that they were feeding on each other and on dead leaves, the bark of trees, lint of fences, etc., and where they were so thick hiding amid its leaves that fifty to a hundred occured to the square foot. The immunity of the plant is the more remarkable since the other species of the genus do not escape.

CONTRAST IN SUMMER AND FALL.

By the end of July the whole ravaged district began to wear a smiling and promising aspect, in strong contrast to the desolation of a month before. In Missouri, in the non-ravaged districts, the wheat harvest was interfered with by the exceptionally heavy rains that prevailed at the time; but in most other parts of the country within the locust district the reports were most encouraging. In Minnesota the crops in the counties ravaged in 1874 yielded well. In Dakota the crops of wheat, oats and barley were reported, around Yankton, as promising to be the best ever harvested. In Colorado everything looked splendid, after the locusts left. The people of Iowa and Kansas, in general, were jubilant over their brightened and encouraging prospects, though, as in Missouri, the heavy rains retarded and somewhat reduced the grain harvest. In Indian Territory the wheat crop was reported as the largest ever gathered in that part of the country. In August the contrast became still more gratifying, and in our own stricken counties the finest crops the people had witnessed for years, were reported, of corn, Hungarian grass, prairie meadow, buckwheat and vegetables of all kinds. Larger areas had been planted to corn than ever before. In September the change which three months had wrought needed to be seen to be appreciated, and never in the history of those counties had root crops done so well, or vegetables of all kinds attained such immense proportions.

NO EVIL WITHOUT SOME COMPENSATING GOOD.

Not to mention the valuable experience and the quickening influence that are generally gained in temporary adversity, there are other ways in which good will grow out of the locust troubles. The chinch bugs filled the air last Spring throughout the stricken district, and many persons feared that they would destroy the corn crop even if the locusts left. I then argued that there was no danger of such a result, and that there was every reason to expect less injury from this cause than usual, and with a wet Summer, which might be expected, an almost total annihilation of the pest. With everything eaten by the locusts, the female chinches, instead of being quietly engaged, unseen, in laying eggs, as they usually are in May, were flying about, seeking plants on the roots of which to consign their eggs. For this reason they were more noticeable. Once fully developed in the ovaries, and the eggs must be laid, and the great bulk of them were necessarily laid where the young hatching from them were destined to perish, as the result proved; for, injurious as the species had been for the two or three previous years, scarcely a specimen was to be found in the Fall. Indeed, I think we may safely conclude that, as a consequence of the locusts and the rain, the farmers of our western counties will not suffer from the Chinch Bug for the next two years at least. The same will hold true of many other insect pests, which were starved out last Spring; and while some of our common native locusts were so thick in the Fall, in the eastern portion of the State, as to do serious injury to fall wheat and garden truck, scarcely one could be found in the counties most ravaged last Spring by the *spretus*.

The unusual productiveness of the soil in the stricken country was on all hands noted during the year, and was owing, in no small degree, to the rich coating of manure which the locusts left. In the form of excrement and dead locusts, the bulk of that which was lost in Spring was left in the best condition to be carried into the soil and utilized. The introduction of new seed from other States was also beneficial.

Nature generally maintains her averages, and whenever diminished southern winds, drouth and locusts have prevailed, the opposite conditions are very apt to follow, and give us plenteous harvests in the place of short crops.

INJURY TO FRUIT AND FRUIT TREES.

It is doubtful if grain-growers and stock-raisers suffered as much in the end as fruit-growers, from the locust injuries. The injury was less felt by these at the time, but was in many instances more lasting and serious. Most trees would survive one or two defoliations, but in many cases no leaves were permitted to grow for weeks, just at the season when they are most needed. This was especially the case with low shrubs, such as gooseberries and currants, in which the insects were fond of roosting. Where not excessively numerous, heart-cherries were preferred over others, and the insects would pass through a strawberry bed and only clean out the weeds. A great many trees were killed outright, and it was often found necessary to cut down the grape-vines. Trees not killed were often badly barked and lost many limbs, except where protected by ditches no orchards yielded fruit. Many trees put forth a few secondary blossoms after the insects left, and a few small apples were noticed on such in autumn.

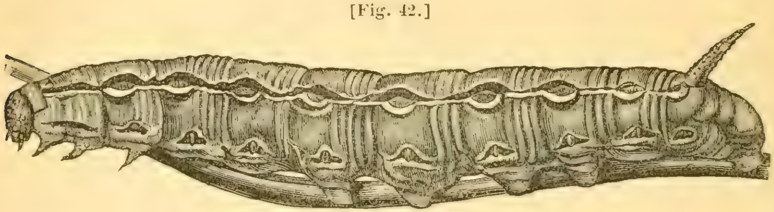
FOOD PLANTS.

I have little to add to what was said under this head last year. The Minnesota Commission found that the bearded varieties of wheat escaped with less damage from the winged insects than smooth varieties, owing as they think to the fact that the insects are deterred by the long beards from attacking the heads, and confine their injuries to the stalks and leaves. Mr. G. M. Dawson, in his "Notes" already cited, suggests that to their known dislike of Leguminous plants we may perhaps attribute the large number of such found on the western plains. The *Amarantus Blitum* is the only plant which I found the insects to refuse last Spring, when driven to extremities.

CHANGES THAT FOLLOWED THE LOCUSTS.

The invasions into a country of large numbers of animals, whether men or insects, are often followed by changes in the vegetation of that country. Certain strange plants are said to yet mark the path through the Southern States which Sherman's soldiers took in their march to the sea, and a number of plants new to the country are known to have been introduced into France by the Germans during the late Franco-Prussian war. So the locust incursions and devastations in Kansas and Missouri were followed by some curious changes. These changes consisted mostly in the great prevalence of plants that in ordinary seasons are scarcely noticed. The *Amarantus Blitum* already spoken of spread at an unprecedented rate, and grew in great luxuriance. Immediately after the locusts left, the common purslane started everywhere and usurped the place of many other species. The common nettle (*Solanum Carolinense*), and the sand burr (*S. rostratum*),

[Fig. 42.]

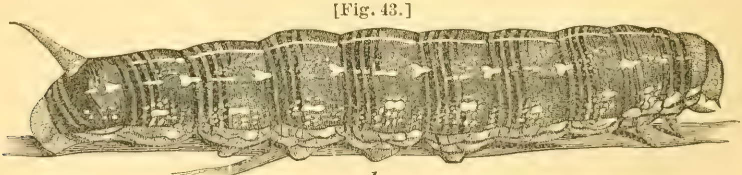


a

Green Larva of White-lined Morning Sphinx.

spread to an alarming degree, and the Poke weed (*Phytolacca decandra*), was very abundant. All kinds of grasses grew very luxuriantly during the Summer, a fact due to the wet and favorable weather; but some kinds * that are rare in ordinary seasons, got the start and grew in great strength and abundance. Among these none are more notable than the sudden appearance very generally over the locust-devastated region, of what is usually called a new grass. Springing up wherever the blue grass gets killed out it proves a God-send to the people, for while it is young and tender cattle like it and fatten upon it. This grass is the *Vilfa vaginæflora*, an annual which

[Fig. 43.]



b

Black Larva of White-lined Morning Sphinx.

is common from the Atlantic to the Rocky Mountains. Unnoticed during ordinary seasons, the destruction of the blue grass and other plants by the too close gnawing of the locusts, gives it the advantage in the struggle for existence—an advantage which is soon lost, however, as the normal relations between species are assumed again in a few years after the disturbing influence has ceased to be operative.

* Prof. G. C. Brodhead (Trans. St. Louis Ac. Sc. III, p. 348) mentions more particularly, *Aristida oligostachya*, in ordinary seasons of rare occurrence around Pleasant Hill, as reaching the unusual height of two feet, and being very abundant. *Eragrostis poœoides*, ordinarily recumbent and scarcely noticed in yards and along roadsides, grew in profusion and 3½ feet high, "looking like meadows ready to be mowed." *Panicum sanguinale* was luxuriant enough to cut for hay.

Indeed, since the Vilfa ripens and dies early in the Fall, the blue grass gains ground the very first year, and afterward easily retains supremacy. The wide-spread appearance of the Vilfa, following the locusts, has been explained on the hypothesis that the latter brought the seed from the West and passed it undigested with their droppings. The fact that the seed is a line long, and not particularly hard, aside from the other facts in the case, renders such a hypothesis unreasonable. Being an annual, the seed was scattered the previous Fall, and naturally starting, we may presume, about the time the insects left, the species got the ascendency.

Some persons were quite alarmed at the prevalence of large green and black worms, soon after the locusts left. Feeding upon purslane and prevailing to an unusual degree, because of the unusual prevalence of this plant, they generally did good by keeping this weed down and converting it into manure. In some few instances, however, they swarmed to such an extent as to devour all the purslane, when they attacked grape-vines, and as Mr. Thos. Wells, of Manhattan, Kansas, informs me, even cut off corn when it was about a foot high. These worms were the variable larvæ of the White-lined Morning Sphinx, a pretty moth often seen hovering over flowers at evening. The species was treated of in my third Report (p. 140) and the illustrations are herewith reproduced. Most insects that naturally feed in Spring above ground on low vegetation were killed out, and the only species unaffected by the visitation were those feeding on forest trees, or living in the ground or in the trunks of trees. The White-lined Morning Sphinx, was just issuing from the pupa, which had remained undisturbed below ground, when the locusts were leaving. It found the purslane—its favorite food-plant—everywhere springing up and abundant, and its eggs were laid without difficulty, and the young larvæ did not, in any case, lack for food. As a consequence they prevailed to a remarkable degree.

[Fig. 44.]

White-lined Morning Sphinx.

THE LOCUSTS DID NOT RETURN IN THE FALL.

In the scourged district the people were very anxious lest another invasion like that of the previous year should occur. I did not hesitate to insist through several journals that there was no danger of a general invasion. None of the insects were noticed to return in autumn in Iowa and Nebraska, and though there are authenticated instances of a few scattering individuals, or of small swarms flying over parts of Kansas and Missouri, and settling without doing damage, yet in the majority of instances thistle down and the downy portion of cottonwood seed, were proved to be the occasion of the reports that were made of flying locusts.

The specimens I have obtained of these returning individuals are like those which developed in the same territory during the Spring, i. e. somewhat darker and below the average size of the typical species; which indicates that they did not come from the extreme northwest, but more probably from nearer home, and perhaps from Colorado. In September a few flights also came into Texas from the north.

As a rule the ravaged districts were remarkably free in the Fall of most insects and especially of locusts. Those individuals that did not get away in June were, as one of my correspondents, Mr. J. Coen, of Jackson Station, remarks "loaded with parasites and soon died;" while the native species were scarce.

NATURAL ENEMIES.

I have no important additions to make to the list of these instanced last year. The good offices of birds were everywhere noticed, and Mr. Wise, of the Minnesota Commission, is of opinion that the blackbirds and prairie chickens destroyed a large portion of the eggs laid in that State in 1875, scratching for them after the fashion of hens. Prof. F. H. Snow, of Lawrence, Kansas, found the young locusts in the gizzards of the Red-eyed Woodpecker (*Melanerpes erythrocephalus*,), Yellow-billed Cuckoo (*Coccyzus Americanus*), Cat-bird (*Mimus Carolinensis*), Red-eyed Vireo (*Vireo olivaceus*), Great-crested Flycatcher (*Myiarchus crinitus*) and Crow Blackbird (*Quiscalus versicolor*), species that had not been noticed to feed on them before. I found the young insects in our own counties pursued by many predaceous beetles, especially those (p. 52) that attack the Army Worm. I also found several species of predatory soldier-bugs attacking them; and Mr. Dan. Carpenter, of Barry, refers, by letter, to the frequency with which the locusts in his neighborhood were noticed to be infested with "slender worms measuring often fourteen to eighteen inches in length," which were without doubt hair-worms, (*Gordii*)—well known to infest several other species of Caloptenі. None of these enemies are so effectual in their work as the mites and Tachina-flies.

REMEDIES AGAINST THE UNFLEDGED INSECTS.

The war waged against the young insects last Spring was energetic and untiring, and everything that human ingenuity could conceive was employed in the conflict. Trapping, burning, tramping, poisoning, trenching, were all resorted to. In some cases whole acres were surrounded with boards and the insects imprisoned until they starved, while in others coal tar was smeared on to fences and outhouses in order to hold fast the newly-hatched swarms that settled thereon.

The means to be employed against the ravages of this insect in the more fertile country subject to its periodical visitations, but in which it is not indigenous, may be classed under five heads: 1. Natural agencies; 2. Artificial means of destroying the eggs; 3. Such means of destroying the unfledged young; 4. Remedies against the mature or winged insects; 5. Prevention. Having considered these measures last year, I shall treat here principally of the second, third and fifth, bringing together the more valuable experiences of the year. In a paper on "The Locust Plague: How to avert it," read before the American Association for the advancement of Science last August, I wrote as follows:

Artificial Means of Destroying the Eggs.—The fact that man can accomplish most in his warfare against locusts by destroying the eggs has long been recognized by European and Asiatic governments liable to suffer from the insects. The eggs are laid in masses, just beneath the surface of the ground, seldom to a greater depth than an inch; and high, dry ground is preferred for the purpose. Very often the ground is so completely filled with these egg masses, that not a spoonful of the soil can be turned up without exposing them, and a harrowing or shallow plowing will cause the surface to look quite whitish as the masses break up and bleach from exposure to the atmosphere. Great numbers will be destroyed by such harrowing or plowing, as they are not only thereby more liable to the attacks of natural enemies, but they lose vitality through the bleaching and desiccating influence of the dew, and rain, and sun. If deeply turned under by the plow, many of them will rot, and the young that chance to hatch will come forth too late the next year to do much harm—providing the same ground be not re-turned so as to bring the eggs to the surface in the Spring.* Excess of moisture for a few days is fatal to the eggs, and they may very easily be destroyed where irrigation is practicable.† Where stock can be confined and fed on soil filled with such eggs, many of these will be destroyed by the tramping. All these means are obviously insufficient, however, for the reason that the eggs are too often placed where none of them can be employed. In such cases they should be collected and destroyed by the inhabitants, and the State should offer some inducement in the way of bounty for such collection and destruction. Every bushel of eggs destroyed is equivalent to a hundred acres of corn saved, and when we consider the amount of destitution caused in some of the Western States by the locust invasion of 1874, and that in many sections the ground was known to be filled with eggs; that, in other words, the earth was sown with the seeds of future destruction—it is surprising that the legis-

*The beneficial results of plowing under or turning up the eggs are fully demonstrated in the report of the Minnesota Commission.

†The efficacy of irrigation or inundation in destroying the eggs will, of course, depend very much on the character of the soil, and may be of little service in a tenacious clay.

latures of those States did not make some effort to avert future injury by offering a liberal price per bushel for the eggs. A few thousand dollars taken out of the State treasury for this purpose would be well spent and be distributed among the very people most in need of assistance.

Destruction of the Unfledged Young.—As I have stated in the articles already alluded to, heavy rolling, where the surface of the soil is sufficiently firm and even, destroys the larger portion of them, but is most advantageously employed when the insects are most sluggish. They drive almost as readily as sheep, and may be burned in large quantities by being driven into windrows or piles of burning hay or straw. But the experience of the present year convinces me that by far the most effectual way for man to protect his crops and do battle to these young locust armies—especially where, as in West Missouri, last Spring, there was no hay or straw to burn—is by ditching. A ditch two feet wide and two feet deep, with perpendicular sides, offers an effectual barrier to the young insects. They tumble into it and accumulate, and die at the bottom in large quantities. In a few days the stench becomes great and necessitates the covering up of the mass. In order to keep the main ditch open, therefore, it is best to dig pits or deeper side ditches at short intervals, into which the hoppers will accumulate and may be buried. We hear much talk about the powerlessness of man before this mighty locust plague; but I am quite confident that here we have a remedy that is at once thorough and effectual, whereby the people of some of the States, at least, may avert in future such evil as that which befell them this Spring. There have been a number of partial attempts at ditching by simply turning a couple of furrows with the plow. Even these will often divert the encroaching insects from their course; but they can never be relied on, and you may rest assured that whenever you hear a man declare that ditching is no protection, he refers to such slovenly, half-made ditches. No instance has come to my knowledge where a ditch, such as I first described, has failed to effectually keep off the insects. Made around a field about hatching time, few hoppers will get into that field till they acquire wings, and by that time the principal danger is over, and the insects are fast disappearing. If any should hatch within the inclosure, they are easily driven into the ditches dug in different parts of the field.

Just behind the fair-grounds at Kansas City there is an intelligent and industrious gardener, Mr. F. D. Adkins, having about three acres in vegetables. The locusts hatched in large numbers all around Kansas City, and nowhere more abundantly than in the immediate vicinity of this truck-garden. Mr. Adkins, remembering his experience with the same plague in 1867, persevered in ditching for their destruction in 1875; and though the surface of the country for miles and miles around was desolate, yet this little three-acre field was untouched—a perfect oasis in the desert, at once giving pleasure to the eye and speaking eloquently of what may be accomplished by a little tact and perseverance. Rush Bottom, in Jackson county, contains a large tract of land in a bend of the Missouri river, naturally protected on all sides but one by the river, and Mr. Ragan relates that, taking advantage of this circumstance, the inhabitants cut a ditch across the neck of land at the foot of the bluff—cutting off the marching column of locusts from the surrounding country. They thereby saved their gardens and hundreds of acres of corn and oats.

Mr. S. D. Payne, of Kasota, Minn., says in the Report of the Minnesota Commission: "In my mind the most practical mode, not only of protecting the crops but of destroying the plague, is the ditching system. I have demonstrated to my own satisfaction that an individual farmer can protect himself both against those bred on his farm (by carefully noting the breeding-grounds and the consequent points of invasion) and those raiding from the neighboring country; and a general concert of action by all the farmers will tend to vastly decrease the numbers, if not entirely remove those hatching here." Numerous other instances of this kind might be given, and I have not a doubt but that with proper and systematic ditching early in the season, when the insects first hatched, everything could have been saved with comparatively little trouble. I have seen people driving off the young locust day after day, in their endeavors to save some small vegetable or flower garden—their efforts eventually in vain—where one-tenth the time spent in ditching would have effectually accomplished the object. And when I should, perhaps, have been praying, I have witnessed sights that prompted to thought and word the very reverse of prayer. In a large portion of Johnson county the injury was slight, and until the end of May little damage was done around Warrensburg. Happening to be in the vicinity of this town on the 3d inst., I came upon a beautiful vineyard which had up to that time escaped. The insects had got into it, and the owner was advised to ditch to save it. His piety exceeded his good sense, however, and instead of genuflecting on a spade he was performing the operation in another way, while his beautiful vineyard was literally being gobbled up at a rate that would not show a green leaf by the morrow. I respect every man's faith, but there are instances where I would respect his work a good deal more.

Where water can be let into the ditches so as to cover the bottom they may be made shallower, and still be effective. Mr. Frank Holsinger, of Kansas City, under date of May 23rd, 1875, sent me the following account of his experience :

Your very interesting communication to the St. Louis *Globe* was reproduced in our *Journal of Commerce* of the 21st inst. I have no doubt but that your counsel will be heeded by many, but to the mass of our people it is as "sounding brass," etc. During the past four days I have been at work, and although I spent less than one-fourth of my time to the purpose, I have destroyed between 30 and 40 bushels of wingless locusts. My remedy is so simple I concluded to give it to you, as I think it better than any I have yet seen, and had I known how easily it was to accomplish I would now see growing crops where ruin and desolation appear.

As they had entered my wheat (I took your advice and Fall-plowed everything, and I do not think there was a hatfull hatched on my 40 acres) from neighboring farms, and knowing that when they got through they must move in force on my garden, I cautioned my wife to inform me when they commenced on this last. On the 18th inst., at 11 A. M., she gave the watchword, "they come;" so, leaving corn-plowing, I hastened to surround our garden with a board fence, intending to drive the insects around, but to no purpose, although the boards were placed at 45° outward, and some six of us were at work. Still they came. We built straw fires next—still unsatisfactory. I had been underdraining, and had some drains still open. Wife said, "you will work yourself sick, and all to no purpose." I take a look, and a patch of early potatoes, one-third of an acre, which we had saved, was melting before them. I then saw them march straight for the drain. My impulse then was to burn them in the drain. This I found difficult. The next thought was "pit-falls at intervals in the drain;" I commenced digging these, and the locusts tumbled in by thousands, but many escaped. Now the thought occurred that if there was water in the pits they *could not jump;* so water was thrown in, and the result was a success. I feel certain that by a judicious expenditure of $50, in ditching around my 35 acres, I could have saved everything, while my loss is largely in excess of $1,000.

The width and depth of the ditch is important, and as experience differed somewhat I have been at pains to get the experience of a large number of correspondents addressed by circular. Many successfully used ditches 2 feet deep and 18 inches wide; a few made them only 18x18; those who used water found 12x15 sufficient, while the larger number used a ditch such as I have recommended, viz.: 2 feet deep by 2 feet wide, with perpendicular sides. At the winter meeting of the Kansas State Horticultural Society, Dr. J. Stayman, of Leavenworth, insisted that a ditch 3 feet wide had not prevented the insects from crossing on his place. Thinking that his experience, so different to that of the majority of his own people, might be accounted for by the character of his soil and other circumstances, I got him to promise to send me a detailed statement, and to give me the similar experience of others, which he asserted he could do; but I have not heard from him since. Mr. Jas. Hanway, an intelligent correspondent of the *Kansas Farmer*, and who, at my request, has been to some trouble to get the experience of Kansans on this point, writes that the ditches generally made were from 18 to 20 inches wide, and about 12 inches deep. Professor Thomas is of opinion, from what he has seen in Colorado, that while a ditch such as I have recommended will prevent the larvæ from crossing, "the pupæ, though halting for a time, will soon make the leap." That they *can* do so, every one who has had experience knows; and so can the larvæ; but the fact remains, as I had abundant evidence last Spring, that in practice they seldom do when hatching out in our part of the country, and that even when the majority are in the pupa state, the 2 foot ditch is still quite effectual. Even the larger winged Acridii and Œdipodæ tumble into such a ditch, and seldom get out again. I would remark in this connection, also, that a ditch 3 feet wide, unless correspondingly deep, will be more apt to permit the insects to escape, when once in, than a narrower one. In hopping, the more perpendicular the direction the insects must take the shorter will be the distance reached. Whenever our farmers are again troubled with the unfledged myriads, the 2-foot ditch, used in time, will be found all sufficient.

Next to ditching the use of nets or seines, or converging strips of calico or any other material, made after the plan of a quail net, proved most satisfactory. By digging a pit, or boring a post augur hole, 3 or 4 feet deep, and then staking the two wings so that they converge toward it, large numbers of the locusts may be driven into the pit after the dew is off the ground. By changing the position of this trap, much good can be done when the insects are yet small and huddled in schools; but all modes of bagging, netting and burning become comparatively useless when the insects begin to travel in concert over wide stretches of land. The same may be said of all mechanical contrivances to facilitate the destruction of the insects: they are useful if used in concert in a given neighborhood soon after the young hatch, but subsequently do not compare to ditching. Mr. Charles D. Zimmerman, of Buffalo, N. Y., has sent me the plan of an immense bag, by which he found that he could catch large quantities of native species. To a frame 15 feet long and 3 feet high is tacked a stretch of cheap cotton cloth. The stuff is closed at the ends, and when the frame is mounted on wheels, and drawn across a meadow, the locusts accumulate in the bag which drags on the ground, and there form a tangled mass and do not escape. The same style of bag, on a larger scale and drawn with a horse at each end, and with an arrangement whereby the lower edge of the bag could be unhooked from the frame and the accumulated insects dumped into pits, would prove useful. Mr. J. Hetzel, who has had considerable experience at Longmont, Col., writes me that the best means he has seen of fighting the locusts, if they do not hatch on the ground, is a burner drawn by horses. "It is 12 feet long, 2 to 2½ feet wide and made of iron, set on runners 4 inches high. An open grate on the top of the runners is filled with pitch pine wood, and a sheet covers the grate to keep the heat down. Two men and a team will burn 10 to 12 acres a day, and kill two-thirds of the insects, but it requires a hot fire." Mr. C. C. Horner gives in the *Colorado Farmer* the following more detailed description of what appears to be the same machine:

It consists of three runners made of 2x4 scantling three feet in length, to be placed six feet apart, making the machine twelve feet wide, runners to be bound together by three flat straps or bars of iron (the base being 12 feet long.) Across the top, bars of iron hold the runners firmly together and form a frame across which wire can be worked, to make a grate to hold fire. The upper part of the runners should be hollowed out so that the grate may glide along within two inches of the ground. A sheet iron arch should be set over this grate to drive the heat downward. This machine is very light and can be worked with one horse; pitch-wood is best adapted for burning and can be chopped the right length and size and left in piles where most convenient, when needed. This machine is intended to be used when the little hoppers just make their appearance along the edge of the grain, going over the ground once or twice each day, or as often as necessary to keep them killed off. The scorching does not kill the grain but makes it a few days later. This is certainly the cheapest manner of getting rid of this pest, as well as the most effectual.

Mr. Rufus Clark, of Denver, according to the same paper, uses a piece of oil cloth, nine to twelve feet long, and six feet wide; one side and each end is secured to light wooden strips by common carpet tacks, and the corners strengthened by braces.

"The oil cloth is smeared with coal tar, purchased at the Denver Gas Works for $7.50 per barrel, and the trap is dragged over the ground by two men—a cord about ten feet long being fastened to the front corners for that purpose. The entire expense of the "trap" is about $3.50, and as it is light and easily handled will be found serviceable on small as well as large farms."

Zinc instead of oil cloth has also been used for the same purpose.

The experience of last Spring shows that when the insects are famishing, it is useless to try and protect plants by any application whatever. Sweetened water seemed to keep the winged insects off special plants in 1874; but it certainly has no such effect on the unfledged hoppers, for they " went for " plants which I thus sprinkled even more voraciously than for those not sprinkled. Lime does not deter them; neither coal oil nor cresylic soap will keep them from eating; and Paris green, though it undoubtedly kills those which partake, is yet no protection to plants, because those which go off to die somewhere after partaking are continuously followed by others which go through the same experience. I gave carbonic acid gas, from a Babcock fire extinguisher, a thorough trial under many different circumstances and conditions, but without any satisfactory results. It had very little effect upon them even when played upon them continuously and at short distance. They often became numbed by the force of the liquid but invariably rallied again.

The best means of protecting fruit and shade trees deserves separate consideration. Where the trunk is smooth and perpendicular, they may be protected by whitewashing. The lime crumbles under the feet of the insects as they attempt to climb, and prevents their getting up. By their persistent efforts, however, they gradually tear off the lime and reach a higher point each day, so that the whitewashing must be often repeated. Trees with short, rough trunks, or which lean, are not very well protected in this way. A strip of smooth, bright tin answers even better for the same purpose. Encircling the tree in any of the different ways suggested for preventing the ascension of the female Canker Worm, puts an effectual estoppel on the operations of the young locusts above the point of attachment, for they cannot jump on a perpendicular surface. A strip of tin three or four inches wide brought around and tacked to a smooth tree will protect it; while on rougher trees a piece of old rope may first be tacked around the tree and the tin tacked to it so as to leave a portion both above and below. Passages between the tin and rope or the rope and tree can then be blocked by filling the upper area between tin and tree with earth. The tin must be high enough from the ground to prevent the hoppers from jumping from the latter beyond it; and the trunk below the tin, where the insects collect, should be covered with some greasy or poisonous substance to prevent girdling. This is more especially necessary with small trees; and kerosene or whitewash having Paris green mixed with it will answer as such preventives.

One of the cheapest and simplest modes employed last Spring was, to encircle the tree with cotton batting into which the insects would entangle their feet, and thus be more or less obstructed. Strips of paper covered with tar, stiff paper tied on so as to slope roof-fashion, strips of glazed wall-paper, thick coatings of soft soap, were used with varying success; but no estoppel equals the bright tin; the others require constant watching and renewal, and in all cases coming under my observation some insects would get in to the trees so as to require the daily shaking of these morning and evening. This will sometimes have to be done when the bulk of the insects have become fledged, even where tin is used; for a certain proportion of the insects will then fly into the trees. They do most damage during the night, and care should be had that the trees be unloaded of their voracious freight just before dark.

One of my correspondents, Capt. John R. Wherry, of Boonville, has suggested the use of strips of canvass, dipped in liquid sulphur and attached to stakes to be stuck in the ground. He thinks that if the strips are lit at evening the fumes will drive the insects away from the locality they pervade. The suggestion strikes me quite favorably as a means of protecting orchards, and I would recommend its trial to the people of Colorado and the Mountain region, who will doubtless have the opportunity the present year. The strips should be dipped in hot sulphur, allowed to cool, and then staked to the windward of the orchard, if the wind is stirring.

HOW TO AVERT THE LOCUST INJURIES: PREVENTION.

The measures so far recommended have in view the destruction of the insects when once they are upon us. The question very naturally arises, "Can something not be done to prevent the incursions of the species into the more fertile States in which it is not indigenous?" In the previously quoted paper read at Detroit, I gave it as my opinion that "the proper way to deal with this insect is to attack it in its native breeding places. It is a fact that does not speak well for some of the countries of the Old World subject to locust injuries, that it is to this day not known whence many of the devastating swarms have their origin. But because European nations have hitherto shown lethargy on this subject, it is no reason why we should. Let us rather in this, as we have in many things, set an example which they will be glad to follow. * * * Our efforts should be confined to the restriction of the species within its natural limits.

The most important results are likely to flow from a thorough study of the Rocky Mountain Locust in its native haunts and breeding places. By learning just when and how to strike the insect, so as to prevent its undue multiplication there—whether by some more extensive system of irrigation, based on improved knowledge of the topography and water supply of the country, or by other means of destroying the eggs—we may hope to protect the fertile States to the East from future calamity."

One of the best means of checking the increase of the species in its native haunts, will be found in the encouragement and increase of its natural enemies, especially the game birds, and the example of Kansas should be followed in enacting stringent laws for their protection. The introduction of the English sparrow has been recommended. From what I know of the bird both here and in its native country, I should expect little aid from it in this line, and if it can thrive to the northwest, it will soon spread there, as it is rapidly multiplying at several points along the Mississippi. We may expect more good from the encouragement of native Locust-feeding species. Prof. Thomas has suggested that inducements be offered to the Indians to collect and destroy the eggs and young along the west side of the plains. Some system of preventing the extensive prairie fires in Fall that are common in the country where the insect naturally breeds, and then subsequently firing the country in the Spring after the young hatch and before the new grass gets too rank, might also be adopted. But whatever the means employed, they must be carried on systematically and on a sufficiently extended and comprehensive scale; and this brings me to the subject of

LEGISLATION, BOTH NATIONAL AND LOCAL.

It is very evident that if anything can be done at all in averting this evil, it must be done by national means. No one individual can acquire the requisite knowledge. The importance of having the matter properly investigated by the national government has been repeatedly urged by many prominent persons in the west, best competent to judge. The feeling has been very general of late years, both among scientific men and intelligent agriculturalists, that the work of our Agricultural Department, in the line of economic entomology, has fallen very far short of the expectations of the people. Whether this is owing to the character of its present management, or to the nature of the Department organization, is immaterial in this connection. The feeling has found expression in our agricultural journals, and in resolutions passed by various agricultural and horticultural societies. These resolutions have lately assumed the more substantial form of a memorial, indorsed by several important agricultural and horticultural societies, and signed by many prominent farmers, fruit-growers and scientific men, urging Congress to create a commission that shall have for its object a thorough investigation of the principal insect pests of our agriculture, and particularly the one in question.

Two bills have, in consequence, been introduced during the present session of Congress, and referred to the Committees on Agriculture.

The first (Senate bill 158) was introduced by Senator Harvey, of Kansas, and appropriately referred in the Senate; it was subsequently introduced in the House by Mr. Patterson, of Colorado, and there properly referred. It is entitled "a bill to provide for an investigation as to the habits of the Rocky Mountain locusts, or so-called grasshoppers," and provides as follows:

That the Commissioner of Agriculture be authorized and requested to appoint three commissioners, having the requisite scientific knowledge to constitute a competent commission, whose duty it shall be to visit the native breeding places of the said locusts, in the Rocky Mountains or elsewhere; and report as to the best method of preventing the incursions or irruptions of the said locusts into the adjacent fertile States and Territories.

That the Treasurer of the United States is hereby authorized to pay the expenses incurred in making this investigation, upon the presentation of the proper vouchers approved by the Commissioner of Agriculture.

The second bill, (S. 438,) was introduced by Senator Ingalls, of Kansas, and properly referred. It provides as follows:

That the Secretary of the Interior shall have authority to appoint a Board of Commissioners, and to fill all vacancies which may occur therein, on the nomination of the National Academy of Sciences, to consist of three entomologists eminent in their profession.

That the said Commissioners shall devote themselves to the investigation of those insects which are most destructive to the crops of farmers and planters, and especially of the Rocky Mountain Locust, the Chinch-bug, the Army Worm, the Cotton-worm, the Hessian fly, and other insects injurious to the great staples, corn, wheat and cotton, in order to devise successful methods for the destruction of such insects. The Commissioners shall report the results of such investigations and methods, at least once in each year, to the Secretary of the Interior, by whom the same shall be transmitted to Congress. As soon, also, as the information gathered shall enable them, the Commissioners shall compile practical instructions for the repression of the different insects referred to.

That the said Commissioners shall be appointed for the term of five years, and vacancies shall be filled for the residue of the term only, and they shall respectively receive $5,000 per annum, to be paid monthly from the date of the original appointment, and shall have clerical assistance, office room, fuel, stationery, chemicals and traveling expenses, not to exceed —— thousand dollars per annum.

The first is open to the objections that it sets no limit to the expenses of the commission, and that it leaves the appointing power with the present Commissioner of Agriculture. Even were Mr. Watts' competency to choose wisely in such a field not questionable, the work intrusted to a commission such as that called for, is too important and serious to leave in control of any one individual. If Mr. Watts had had any due appreciation of the needs of Western agriculture, he would long ere this have taken steps to have the work performed which it is designed that such a commission shall perform, and would have asked for the proper appropriations to enable him to do so, instead of making large annual demands on Congress to enable him to run a competition with legitimate seedsmen, by establishing a gigantic National seed store, which has been instrumental in doing no small injury by disseminating noxious weeds and insects.

The second bill would far more nearly meet the requirements of the country. It restricts the time during which the commission shall exist, and limits its cost. If the blank be filled in with $10,000, which would be sufficient to cover cost of experiments and other expenses, the annual expense could not exceed, and might fall below, $25,000. It specifies more clearly the duties of the commission, and provides for the investigation of not one, but of several, of our worst insect pests. It gives us, also, the best guarantee of judicious appointments; for if the assembled judgment of such a body as the National Academy of Science—composed mainly of men now engaged in scientific work for the government, and of those who have devoted their lives to applied science—will not give us a competent commission, I know not what will.

The good that a commission properly constituted and supported might do for the country is incalculable. We have made some progress in the field of economic entomology during the past quarter of a century, and particularly during the past decade. The few entomologists that have been employed by different States have made important discoveries and recommendations, while practical men who have kept themselves informed of the knowledge recorded by these officers have not failed to apply it, and have often devised measures and schemes of great value in the warfare against insect pests. Still the State Entomologists have, for the most part, been obliged to confine their attention to investigating the habits of local pests; neither the time nor the means that have been at their command have permitted the carrying on of elaborate and expensive investigations such as those we may expect from a National Commission more generously supported. The consequence is that some of the most injurious insects, such as those mentioned in Senator Ingalls's bill, have never been fully investigated, and to this day there are important points in the history of several of them, that remain a mystery.

The species mentioned in the bill are of national importance, and should receive due attention from the nation. Congress owes it to the farmers of the country, and especially to those of the West, who are in actual need of all the encouragement and aid that can be given to them, that some effort be made to relieve them, as far as it is in human power to do so, of this insect burden which is doing as much as any other to crush them.

In the case of this locust it is not merely the question of saving to the nation, in future, such vast sums of money as this insect has filched from the producers of some of the Western States (amounting during the past three years to many millions of dollars;) it is a question affecting the welfare of whole commonwealths on this side of the Mississippi, and the ultimate settlement of a vast track of country extending from the base of the Rocky Mountains eastward, to which settlement the ravages of the locust in question offer the most serious obstacle.

Yet what has Congress done? The Senate committee reported an amendment providing for the appointment of one Commissioner for one year at a salary of $4,000 and expenses, the appointment to be made by the Secretary of the Interior, the Secretary of the Smithsonian Institution and the Commissioner of Agriculture. This amendment was very much of a farce. No one denies that our agriculture forms the basis of our national prosperity. No one who has given the subject attention can deny—because the figures confront him—that we often lose upward of $200,000,000 annually from insect depredations. Yet when our producers urge that some national effort be made to relieve them wholly, or in part, it takes on this farcical shape. What the late lamented Walsh wrote ten years ago is true to-day:

"Let a man profess to have discovered some new patent powder pimperlimpimp, a single pinch of which being thrown into each corner of a field will kill every bug throughout its whole extent, and people will listen to him with attention and respect. But tell them of any simple common sense plan, based upon correct scientific principles, to check and keep within reasonable bounds the insect foes of the farmer, and they will laugh you to scorn. Probably about nine-tenths of the members of Congress and of our State Legislatures are lawyers, busying themselves principally with law and politics; and the remaining one-tenth are physicians, merchants and manufacturers, with a very small sprinkling of farmers. Is it to be expected that a crowd of men, whose heads are mostly full of such important things as cognovits and assumpsits and demurrers and torts and caucuses and conventions, should condescend to think about 'bugs'? What do they know about farmers, except that they have got votes? Or about farmers' pockets, except that most of the taxes come out of them? What do they know or care about entomology, fancying, as most of them do, that entomologists busy themselves exclusively in collecting the greatest possible number of beautiful butterflies? Talk to them of science, and they smile in your face. They are so perpetually teased and tormented by scientific charlatans—wolves in sheep's clothing—lobbying for legislative assistance for all kinds of ridiculous impossibilities, that they have come to believe firmly that science is only another word for humbug and imposture."

I am confident that if one-hundreth part of the pecuniary damage that is annually inflicted by insects upon the farmers were inflicted, instead, upon the merchants or manufacturers, Congress would long since have given the matter most careful consideration.

What could one man, employed for one year, accomplish where the field is so wide? Our cotton growers have lost hundreds of millions of dollars through the Cotton Worm. Yet to our shame, be it said, no one knows positively, to-day, how the insect passes the Winter, for the simple reason that no extended observations have been made on the subject. One man's time for at least a year, with liberal assistance, would be required to thoroughly investigate this species, to say nothing of the others.

If there is to be National legislation in this line, let it be wise and worthy of the occasion, or let us have none at all. Let us not court failure and disappointment by weakening the power of the commission for good, and thus adding one more to the list of similar commissions that have failed and thus brought discredit on the country and on science.

Both the Ingalls and the Harvey bills were preferable to the amended one; but even the single commissioner was denied, and after debating the amended bill, as reported by the committee for one whole morning, (and those who care to follow the debate in the Congressional Record for March 7, will find rich reading,) the bill was passed in the following form:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be the duty of the Commissioner of Agriculture to investigate and gather information relative to those insects which are most destructive to the crops of planters and farmers, and especially of the Rocky Mountain locust, the chinch-bug, the army-worm, the cotton-worm, the tobacco-worm, the Hessian fly, potato-bug, and other insects injurious to the great staples, wheat, corn and cotton, in order to devise successful methods for the destruction of such insects; and to make public from time to time such information and such practical instructions for the suppression of the different insects referred to.

And thus the debate ended in the fizzle of resolving that it shall be the duty of the Commissioner of Agriculture to perform certain work, which people outside the Senate have been in the habit of supposing to be his duty without any such senatorial instructions; but which duty the present incumbent has failed to perform either from inability or lack of means; and which there is no reason to believe he will any better perform in the future. Let the people of the West remember that this brilliant result on the part of a body which can vote four hundred thousand dollars to protect Goverment clothing from mildew and moths (there was a job in it) but which cannot vote twenty thousand for the protection of our crops, was brought about by the persistent efforts of Senator Logan, who pretends to represent the greatest agricultural State in the Union! Other nations have found it necessary to appoint commissions for the injurious insects of national consequence, and the day will doubtless come when our Government will feel the imperative necessity of doing likewise.

To insure good results to the country, a national entomological commission should consist of at least three persons; it should have at least five years in which to perform its labors; it should have liberal support, and last, and most important of all, it should be composed of competent and experienced men—men who can combine practical experience with scientific accuracy. The services of such can only be insured by decent salaries, and their appointment guaranteed by some such combined selective power as that proposed in Senator Ingalls's bill. Whether or not the subject will be again taken up by the present Congress it is impossible to tell; but I candidly confess that I have little faith that it will receive the serious consideration at Washington that it deserves. Congress is too busy in exposing corruption and peculation to pay much attention to the wants of our insect-cursed farmers. If the annual sum asked for in Senator Ingalls's bill were to maintain some useless diplomatic service in some third-rate foreign land, there would be some chance of getting it; but as it is for the performance of important work that is to redound to the material benefit of the country for all future time, and for the promotion of our most important industry, why, I presume, it will not be granted. But while there seems to be little chance at present of getting any national legislation on this locust matter, the wisdom of State legislation has become obvious in some of the States. Wise laws for the repression of noxious insects can only be enacted where legal and scientific knowledge are combined in the framers of the laws; and it too often happens that legislative bodies show lack of the requisite knowledge of the latter kind. We had an illustration of this last year in the laws passed by several European nations prohibiting traffic in American potatoes, with a view of preventing the introduction of the Colorado Potato-beetle; whereas, as has been abundantly shown in these reports, such a course was not the best, but one of the very poorest, so far as the object had in view was concerned. There is scarcely any possibility of the insect being imported in barreled potatoes, but there is danger of its importation in other ways. In like manner, Algiers, Italy and other south European countries have, during the past year, passed laws with a view of keeping out the Phylloxera, which laws, by being extreme, are calculated to do harm rather than good, and are founded on insufficient knowledge of the insect's habits.

Last Summer some counties in Minnesota, and particularly Le Sueur, Todd, Meeker, Brown, Sibley and Nicollett, offered bounties for the catching and destroying of locusts. The laws had the effect to measurably clean out the insects. The Kansas Legislature, at its late session, also, passed a bill for the destruction of locusts. The bill, though an important step in the right direction, is yet, to my mind, defective in one or two vital particulars. It provides that a bounty shall be paid out of the county treasury, of five dollars for the collection and destruction of every bushel of locust eggs, and sixty cents for the collection and destruction of every bushel of unfledged locusts. The original bill, introduced by Senator Halderman, made a discrimination as to the time of destruction of the unfledged locusts; and I cannot think that the change made in committee was an improvement. As several other Western States will doubtless be led to pass similar acts for protection against locust ravages, and as I sincerely hope that our own Legislature will do so next Winter, I will briefly state what I conceive should be the essential features of any act having that object.

1. *The bounty should be paid out of the State and not the County Treasury.* When any State or portion of a State is afflicted by a locust visitation, the people of the State at large should bear the burden. By a judicious State bounty system that would avert future calamity in any threatened district, the more prosperous portion of the community is made to contribute to the relief of the afflicted, and the whole community in reality gains by the operation.

2. *The bounty should be immediately available to those earning it.* When distress and want stare the people of a locust-stricken district in the face, those who work for a bounty should be able to obtain it with as little delay as possible. This result can, perhaps, best be attained by empowering the Township Trustee, or the Street Commissioner, to receive and measure the eggs or young insects, and to issue certificates setting forth the number of bushels destroyed—the certificates to be filed with the County Clerk, who should issue to the claimant another certificate, setting forth the name and residence of the holder, and the number of bushels of eggs and young locusts collected and destroyed by him. This last certificate should be taken and received by the Collector of the Revenue of the county in which the same was given, and such collector should pay the holder thereof the sum called for under the act, and be allowed pay out of the State treasury for the same.

3. *The act should, as far as possible, tend to the destruction of the Eggs.* Barring exceptional cases, where shallow plowing can be resorted to, the collecting of the eggs will be tedious. It will be safe, therefore, to offer a pretty large inducement to collect them, and \$4 to \$6 a bushel would not be too much, and would give remunerative employment to young people through the mild weather of winter and in late Fall and early Spring.

4. *After the eggs, the destruction of the newly hatched Locusts should be encouraged by the Act.* A bushel of the newly hatched insects will contain thirty or more times as many individuals as will a bushel of the pupæ, and, moreover, their destruction prevents the subsequent injury. It would be folly to pay sixty cents a bushel for them later in the season when they are nearly full-grown and have done most of the harm they are capable of doing. The price offered, therefore, should vary with the season, and while sixty or seventy-five cents should be offered in March, the price should diminish to fifty-cents in April, twenty-five cents in May and ten cents in June. In addition to the foregoing requirements of such an act, every precaution should be taken to prevent fraud and dishonesty in obtaining the bounty.

In order to get the opinions of our own farmers who had experience last Spring as to the value of a bounty, I submitted to many the following question: "Do you not think that a bounty of fifty cents a bushel, offered by the State for the young insects when they were hatching, would have given employment and means to a large number of persons who, on account of the locust ravages, were without work; and would not such a bounty have induced so general a destruction of the insects during the first fortnight of their hatching as to virtually have prevented the subsequent devastation and suffering?" Of over a hundred answers to this question, the opinions are almost unanimously affirmative. Five of the writers believe that it would have availed little last Spring, because the people had no anticipation of the subsequent ravages, but that it would work well in future; and three doubt whether any human effort would have saved their crops. The experience of Minnesota is valuable here, and the State Commissioners do not hesitate to recommend the system after the county trials, imperfect as they were, and commenced as they were in most cases, too late in the season. It was clearly shown that in one township \$30,000 worth of crops was saved by an expenditure of \$6,000. Nicollet county paid \$25,053.00 for 25.053 bushels of locusts, but the price paid by other counties was higher: in fact, much too high. The prices I have suggested are all sufficient; for we must not forget that aside from the bounty inducement, the people who appreciate the situation must feel that they are working for self-protection, and know that it is folly to waste labor in any other way. A law such as I have suggested, once enacted and on our Statute books, might not be called into operation for many years; but would beyond all doubt serve an admirable purpose in the event of a repetition of the evils of 1874 and 1875. Under its provisions, I am confident that in the event of another invasion, during the milder months of Fall and Spring, between the laying and hatching periods, thousands of bushels of eggs will be collected. Suppose $50,000 or $100,000 had thus been taken out of the State treasury last Winter or Spring in the way of bounties. The money would have been well earned and distributed among those who most needed it. The injury done later in the Spring would have been measurably or entirely averted, for every bushel of eggs is equivalent to the future destruction of at least 300 acres of any young crop, and each county comprises on an average not much over 300,000 acres. The smaller bounty for the young hoppers would have worked just as beneficially. It would have given employment to thousands who had nothing to do, and stayed the excuse for raiding which idlers and desperate characters made. Wherever private parties offered even a bounty of 50 cents per bushel for these young, they soon had to desist on account of the numbers brought them; which shows how effectual a State bounty would have been.

In the more thinly settled parts of the country to the west of us, a State bounty system may be more or less ineffectual, so far as the general destruction of the insects is concerned, though it will even there be one of the best means of relieving destitution; but in our more settled counties it will accomplish both ends.

SUGGESTIONS.

As a means of assisting farmers in the destruction of the unfledged locusts by trenches and in other ways I would also urge the employment of military force, a large amount of which, in times of peace, could be ordered into the field at short notice. As stated in my paper read at Detroit: "To many, the idea of employing soldiers to assist the agriculturist in battling with this pest, may seem farcical enough, but though the men might not find glory in the fight, the war—unlike most other wars — could only be fraught with good consequences to mankind. In Algeria the custom prevails of sending the soldiers against these insects. While in the south of France last summer, I found to my great satisfaction, that at Arles, Bouche du Rhone, where the unfledged locusts (*Caloptenus Italicus*, a species closely allied to our Rocky Mountain locust), were doing great harm, the soldiers had been sent in force to do battle with them, and were then and there waging a vigorous war against the tiny foes. A few regiments armed with no more deadly weapons than the common spade, sent out to the suffering parts of Missouri, Kansas and Nebraska last Spring, might in a few weeks have measurably routed this pygmean army, and materially assisted the farmer in his ditching operations.

"Hogs and poultry of every description delight to feed on the young hoppers and will flourish where these abound when nothing else does. It will be well, in the event of a future invasion, for the people in the invaded districts to provide themselves with as large a quantity as possible of this stock. Where no general and systematic efforts were made to destroy either the eggs or the young locusts, and it is found that, as Spring opens, these young hatch out in threatening numbers, the intelligent farmer will delay the planting of everything that cannot be protected by ditching, until the very last moment, or till toward the end of June—using his team and time solely in the preparation of his land. In this way he will not only save his seed and the labor of planting, and, perhaps, replanting, but he will materially assist in weakening the devouring armies. Men planted last Spring, and worked with a will and energy born of necessity, only to see their crops finally taken, their seed gone, and their teams and themselves worn out. The locusts finally destroyed every green thing, until, finding nothing more, they began to fall upon each other and to perish. This critical period in their history would have been brought about much earlier if they had not had the cultivated crops to feed upon; and if by concert of action this system of non-planting could at first have been adopted over large areas, the insects would have been much sooner starved out and obliged to congregate in the pastures, prairies and timber. Moreover, the time required for early planting and cultivation, if devoted to destroying the insects after the bulk of them hatch out toward the end of April, would virtually annihilate them. The multiplication of any species of animal beyond the power of the country to support it, inevitably proves the destruction of that species unless it is able to migrate. Let fifty batches of Canker-worm eggs hatch out on a single, somewhat isolated apple tree, and not one worm will survive long enough to mature. The leaves of the tree will be devoured before the worms are half grown, and the latter must then inevitably perish; whereas, if only a dozen batches of eggs had hatched on that tree, the worms might all have lived and matured. In the same way the young locusts inevitably perish whenever they are so numerous as to devour every green thing before they become fledged; and under certain circumstances, the sooner such a condition of things is brought about the better." The greatest generals and mightiest armies must yield to starvation!

Too much stress cannot be laid on the advantage of coöperation and concert of action, to accomplish which ought not to be difficult, with our present Grange system. One of my correspondents, Mr. Jas. E. Gladish, of Aulsville, Lafayette Co., suggests that, to insure concert of action the supervisors of each school district be authorized to call out every able-bodied man and oblige him to work in a general system of destruction as soon as the young insects commence to travel.

In this connection it is also very obvious that our Signal Service might be made the means of giving important assistance to the farmers of the West, by warning them of coming danger. If, as I believe, the disastrous swarms which reach our State come from the extreme northwest, there is no reason why, by increasing the number of signal stations in that region the movements of large swarms should not be daily recorded, and the farmers to the east and southeast be apprised of their probable coming for weeks in advance. The people might not, it is true, greatly benefit by the information, except in preparing and providing for the possible contingency; but by thus recording the movements of swarms we shall in a few years come to know more about the native breeding places and habits of the species, and as the Bureau perfects its work, we may, through it, learn the Fall before, when the insects have become unduly multiplied or have laid enormous quantities of eggs over large areas in their native habitat, and when, in consequence, an invasion the following year is probable: in which event a larger proportion of small grains and other crops that escape the ravages of the Fall swarms can be planted in the threatened country.

The same plan of allowing the grass to remain unburned until the young hatch in Spring, suggested for the destruction of the insect in its native home, will of course work equally well when the eggs are laid in the country to the east and in our own counties.

As to the best means of disposing of the slaughtered locusts, the easiest and generally employed are burning and burying. Yet the insects might be turned to good advantage as manure, or sun-dried and preserved in cakes to feed to hogs, poultry, etc., and where large quantities are destroyed under a bounty system, some such means of making the most of them should be considered.

Finally, much can be done to avert the evil we recently suffered from, by a judicious choice of crops; but I will consider this matter under the head of

LESSONS OF THE YEAR.

There is nothing surer than that the destitution in our western counties last Spring was as much, if not more, owing to the previous ravages of the Chinch Bug than to those of this locust.

The Chinch Bug is an annual and increasing trouble; the locust only a periodical one. Now, the counties ravaged are among the richest agricultural counties in the State, and, for that matter, can scarcely be surpassed in the country. Consisting of high, rolling prairie, interspersed, as a rule, with an abundance of good timber, these counties produce a very large amount of corn and stock. Of cultivated crops, corn is the staple, and, with a most generous soil it has become the fashion to plant and cultivate little else, year after year, on the same ground. The corn fields alternate more or less with pastures, and there is just enough small grain to breed and nourish the first brood of chinch bugs which pass into the corn at harvest time and scatter over the country, by breeding and harboring in the corn fields. Not to mention the different means to be employed in counteracting the ravages of this insect a diversified agriculture is undoubtedly one of the most effectual. It must necessarily follow that the more extensive any given crop is cultivated to the exclusion of other crops, the more will the peculiar insects which depredate upon it become unduly and injuriously abundant. The chinch bug is confined in its depredations to the grasses and cereals. Alternate your timothy, wheat, barley, corn, etc., upon which it flourishes, with any of the numerous crops on which it cannot flourish, and you very materially affect its power for harm. A crop of corn or wheat grown on a piece of land entirely free from chinch bugs will not suffer to the same extent as a crop grown on land where the insects have been breeding and harboring. This fact is becoming partially recognized, and already hemp, flax and castor beans are to some extent cultivated in the counties mentioned. But there are many other valuable root and forage plants that may yet be introduced and grown as field crops; and if the late calamities only awaken the farmers of that country to a full realization of the importance of greater diversification in their culture, the lesson will not be too dearly bought.

Of root crops that would escape the ravages of the winged insects, and which would grow in ordinary seasons, and furnish excellent food for stock may be mentioned turnips, ruta bagas, mangel wurzel, carrots (especially the large Belgian), parsnips and beets. Of tubers that are not as profitable but of which it would be well to plant small quantities in locust districts, for the reason, as my friend A. S. Fuller suggests, that they grow with such ease, and are less likely to be injured by the insects, the Chinese Yam, Jerusalem Artichoke (*Helianthus tuberosus*), and the Chufa (*Cyperus esculentus*) are worthy of trial.

LOCUSTS AS FOOD FOR MAN.

As considerable merriment was made of certain trials made by myself and others to ascertain the value of the young locusts as food, I give here a paper on the subject, read by me before the last meeting of the American Association for the Advancement of Science:

In the few words I have to communicate under this head, it is not my purpose to inflict a long dissertation on edible insects. The subject has been sufficiently treated of by various authors, and especially by Kirby and Spence in their admirable Introduction to Entomology; while, within the year, Mr. W. R. Gerard has brought together most of the facts in a paper entitled "Entomophagy," read before the Poughkeepsie Society of Natural History. It is my desire, rather, to demonstrate the availability of locusts as food for man, and their value, as such, whenever, as not unfrequently happens, they deprive him of all other sources of nourishment.

With the exception of locusts, most other insects that have been used as food for man, are obtained in small quantities, and their use is more a matter of curiosity than of interest. They have been employed either by exceptional individuals with perverted tastes, or else as dainty tit-bits to tickle some abnormal and epicurean palate. Not so with locusts, which have, from time immemorial, formed a staple article of diet with many peoples, and are used to-day in large quantities in many parts of the globe.

Any one at all familiar with the treasures on exhibition at the British Museum, must have noticed among its Nineveh sculptures, one in which are represented men carrying different kinds of meat to some festival, and among them some who carry long sticks to which are tied locusts—thus indicating that in those early days, represented by the sculpture, locusts were sufficiently esteemed to make part of a public feast. They are counted among the "clean meats" in Leviticus (xi, 22), and are referred to in other parts of the Bible, as food for man. In most parts of Europe, Asia, and Africa, subject to locust ravages, these insects have been, and are yet, extensively used as food. Herodotus mentions a tribe of Æthiopians "which fed on locusts which came in swarms from the southern and unknown districts," and Livingstone has made us familiar with the fact that the locust-feeding custom prevails among many African tribes. Indeed, some tribes have been called *Acridophagi*, from the almost exclusive preference they give to this diet. We have it from Pliny that locusts were in high esteem among the Parthians, and the records of their use in ancient times, as food, in southern Europe and Asia, are abundant. This use continues in those parts of the world to the present day.

In Morocco, as I am informed by one (Mr. Trovey Blackmore, of London) who has spent some time in that country, they do more or less damage every year, and are used extensively for food whenever they abound so as to diminish the ordinary food-supply; while they are habitually roasted for eating and brought into Tangier and other towns by the country people and sold in the market places and on the streets. The Jews, who form a large proportion of the population, collect the females only for this purpose—having an idea that the male is unclean, but that under the body of the female there are some Hebrew characters which make them lawful food. In reality there are, under the thorax, certain dark markings—the species used, and which is so injurious to crops, being the *Acridium perigrinum*. Radoszkowski, President of the Russian Entomological Society, tells me that they are also, to this day, extensively used as food in southern Russia; while many of our North American Indian tribes, and notably the Snake and Digger Indians of California, are known to feed upon them. No further evidence need be cited to prove the present extensive use of these insects as articles of food. Let us then briefly consider the nature of this locust food, and the different methods of preparing it.

The records show us that in ancient times these insects were cooked in a variety of ways. *Œdipoda migratoria* and *Acridium perigrinum*, which are the more common devastating locusts of the "Old World," are both of large size, and they are generally prepared by first detaching the legs and wings. The bodies are then either boiled, roasted, stewed, fried or broiled. The Romans are said to have used them by carefully roasting them to a bright golden yellow. At the present day, in most parts of Africa, and especially in Russia, they are either salted or smoked like red herrings. Chenier, in his account of the Empire of Morocco (London, 1788), says that thus cured, they are brought into the market in prodigious quantities, but that they have "an oily and rancid taste, which habit only can render agreeable." The Moors use them, to the present day, in the manner described by Jackson in his "Travels in Morocco," viz.: by first boiling and then frying them; but the Jews, in that country—more provident than the Moors—salt them and keep them for using with the dish called *Dafina*, which forms the Saturday's dinner of the Jewish population. The dish is made by placing meat, fish, eggs, tomatoes—in fact almost anything edible—in a jar which is placed in the oven on Friday night, and taken out hot on the Sabbath, so that the people get a hot meal without the sin of lighting a fire on that day. In the Abbé Godard's "*Description et Histoire de Maroc*" (Paris, 1860), he tells us that "they are placed in bags, salted, and either baked or boiled. They are then dried on the terraced roofs of the houses. Fried in oil they are not bad." Some of our Indians collect locusts by lighting fires in the direct path of the devouring swarms. In roasting, the wings and legs crisp up and are separated; the bodies are then eaten fresh or dried in hot ashes and put away for future use. Our Digger Indians roast them, and grind or pound them to a kind of flour, which they mix with pounded acorns, or with different kinds of berries, make into cakes and dry in the sun for future use.

The species employed by the ancients were doubtless the same as those employed at the present day in the East, viz.: the two already mentioned, and, to a less degree, the smaller *Caloptenus Italicus*. We have no records of any extended use of our own Rocky Mountain species (*Caloptenus spretus*), unless—which is not improbable—the species employed by the Indians on the Pacific coast should prove to be the same, or a geographical race of the same.

It had long been a desire with me to test the value of this species (*spretus*) as food, and I did not lose the opportunity to gratify that desire, which the recent locust invasion into some of the Mississippi Valley States offered. I knew well enough that the attempt would provoke to ridicule and mirth, or even disgust, the vast majority of our people, unaccustomed to anything of the sort, and associating with the word insect or "bug" everything horrid and repulsive. Yet I was governed by weightier reasons than mere curiosity; for many a family in Kansas and Nebraska was last year brought to the brink of the grave by sheer lack of food, while the St. Louis papers reported cases of actual death from starvation in some sections of Missouri, where the insects abounded and ate up every green thing the past Spring.

Whenever the occasion presented I partook of locusts prepared in different ways, and, one day, ate of no other kind of food, and must have consumed, in one form and another, the substance of several thousand half-grown locusts. Commencing the experiments with some misgivings, and fully expecting to have to overcome disagreeable flavor, I was soon most agreeably surprised to find that the insects were quite palatable, in whatever way prepared. The flavor of the raw locust is most strong and disagreeable, but that of the cooked insects is agreeable, and sufficiently mild to be easily neutralized by anything with which they may be mixed, and to admit of easy disguise, according to taste or fancy. But the great point I would make in their favor is that they need no elaborate preparation or seasoning. They require no disguise, and herein lies their value in exceptional emergencies; for when people are driven to the point of starvation by these ravenous pests, it follows that all other food is either very scarce or unattainable. A broth, made by boiling the unfledged *Caloptenı* for two hours in the proper quantity of water, and seasoned with nothing in the world but pepper and salt, is quite palatable, and can scarcely be distinguished from beef broth, though it has a slight flavor peculiar to it and not easily described. The addition of a little butter improves it, and the flavor can, of course, be modified with mint, sage and other spices, *ad libitum*. Fried or roasted in nothing but their own oil, with the addition of a little salt, and they are by no means unpleasant eating, and have quite a nutty flavor. In fact, it is a flavor, like most peculiar and not unpleasant flavors, that one can soon learn to get fond of. Prepared in this manner, ground and compressed, they would doubtless keep for a long time. Yet their consumption in large quantities in this form would not, I think, prove as wholesome as when made into soup or broth; for I found the chitinous covering and the corneous parts—especially the spines on the tibiæ—dry and chippy, and somewhat irritating to the throat. This objection would not apply, with the same force, to the mature individuals, especially of larger species, where the heads, legs and wings are carefully separated before cooking; and, in fact, some of the mature insects prepared in this way, then boiled and afterward stewed with a few vegetables, and a little butter, pepper, salt and vinegar, made an excellent fricassee.

Lest it be presumed that these opinions result from an unnatural palate, or from mere individual taste, let me add that I took pains to get the opinions of many other persons. Indeed, I shall not soon forget the experience of my first culinary effort in this line—so fraught with fun and so forcibly illustrating the power of example in overcoming prejudice. This attempt was made at an hotel. At first it was impossible to get any assistance from the followers of the *ars coquinaria*. They could not more flatly have refused to touch, taste or handle, had it been a question of cooking vipers. Nor love nor money could induce them to do either, and in this respect the folks of the kitchen were all alike, without distinction of color. There was no other recourse than to turn cook myself, and operations once commenced, the interest and aid of a brother naturalist and two intelligent ladies were soon enlisted. It was most amusing to note how, as the rather savory and pleasant odor went up from the cooking dishes, the expression of horror and disgust gradually vanished from the faces of the curious lookers-on, and how, at last, the head cook—a stout and jolly negress—took part in the operations; how, when the different dishes were neatly served upon the table and were freely partaken of with evident relish and many expressions of surprise and satisfaction by the ladies and gentlemen interested, this same cook was actually induced to try them and soon grew eloquent in their favor; how, finally, a prominent banker, as also one of the editors of the town joined in the meal. The soup soon vanished and banished silly prejudice; then cakes with batter enough to hold the locusts together disappeared and were pronounced good; then baked locusts with or without condiments; and when the meal was completed with dessert of baked locusts and honey *a la* John the Baptist, the opinion was unanimous that that distinguished prophet no longer deserved our sympathy, and that he had not fared badly on his diet in the wilderness. Prof. H. H. Straight, at the time connected with the Warrensburg, (Mo.) Normal School, who made some experiments for me in this line, wrote: "We boiled them rather slowly for three or four hours, seasoned the fluid with a little butter, salt and pepper and it made an *excellent* soup, *actually*; would like to have it even in prosperous times. Mrs. Johonnot, who is sick and Prof. Johonnot pronounced it excellent."

I sent a bushel of the scalded insects to Mr. Jno. Bonnet, one of the oldest and best known caterers of St. Louis. Master of the mysteries of the cuisine, he made a soup which was really delicious, and was so pronounced by dozens of prominent St. Louisans who tried it. Shaw, in his *Travels in Barbary*, (Oxford, England, 1738), in which two pages are devoted to a description of the ravages of locusts, mentions that they are sprinkled with salt and fried, when they taste like crawfish; and Mr. Bonnet declared this locust soup reminded him of nothing so much as crawfish bisque, which is so highly esteemed by connoisseurs. He also declared that he would gladly have it on his bill of fare every day if he could get the insects. His method of preparation was to boil on a brisk fire, having previously seasoned them with salt, pepper and grated nutmeg, the whole being occasionally stirred. When cooked they are pounded in a mortar with bread fried brown, or a puree of rice. They are then replaced in the saucepan and thickened to a broth by placing on a warm part of the stove, but not allowed to boil. For use, the broth is passed through a strainer and a few croutons are added. I have had a small box of fried ones with me for the past two months, and they have been tasted by numerous persons, including the members of the London Entomological Society and of the *Societé Entomologique de France*. Without exception they have been pronounced far better than was expected, and those fried in their own oil with a little salt are yet good and fresh; others fried in butter have become slightly rancid—a fault of the butter. Mr. C. Horne, F. Z. S., writing to *Science Gossip* about swarms of locusts which visited parts of India in 1863, says: "In the evening I had asked two gentlemen to dinner and gave them a curry and croquet of locusts. They passed for Cabul shrimps, which in flavor they very much resembled, but the cook having inadvertently left a hind leg in a croquet, they were found out, to the infinite disgust of one of the party and the amusement of the other."

This testimony as to the past and present use of locusts as human food might be multiplied almost indefinitely, and I hope I have said enough to prove that the nature of that food is by no means disagreeable. In short, not to waste the time of the association in further details, I can safely assert, from my own personal experience, that our Rocky Mountain locust is more palatable when cooked than some animals that we use upon our table. I mention the species more particularly, because the flavor will doubtless differ according to the species or even according to the nature of the vegetation the insects were nourished on. I have made no chemical analysis of this locust food, but that it is highly nourishing may be gathered from the fact that all animals fed upon the insects thrive when these are abundant; and the further fact that our locust-eating Indians, and all other locust-eating people, grow fat upon them.

Locusts will hardly come into general use for food except where they are annually abundant, and our western farmers who occasionally suffer from them will not easily be brought to a due appreciation of them for this purpose. Prejudiced against them, fighting to overcome them, killing them in large quantities, until the stench from their decomposing bodies becomes at times most offensive—they find little that is attractive in the pests. For these reasons, as long as other food is attainable, the locust will be apt to be rejected by most persons. Yet the fact remains that they do make very good food. When freshly caught in large quantities, the mangled mass presents a not very appetizing appearance, and emits a rather strong and not over pleasant odor; but rinsed and scalded, they turn a brownish red, look much more inviting, and give no disagreeable smell.

The experiments here recorded have given rise to many sensational newspaper paragraphs, and I consider the matter of sufficient importance to record the actual facts, which are here given for the first time.

Like or dislike of many kinds of food are very much matters of individual taste or national custom. Every nation has some special and favorite dish which the people of other nations will scarcely touch, while the very animal that is highly esteemed in one part of the country is not unfrequently rejected as poisonous in another section. We use many things to-day that were considered worthless or even poisonous by our forefathers. Prejudice wields a most powerful influence in all our actions. It is said that the Irish during the famine of 1857, would rather starve than eat our corn bread; and if what I have here written shall, in the future, induce some of our Western people to profit by the hint, and avoid suffering from hunger or actual starvation, I shall not have written in vain.

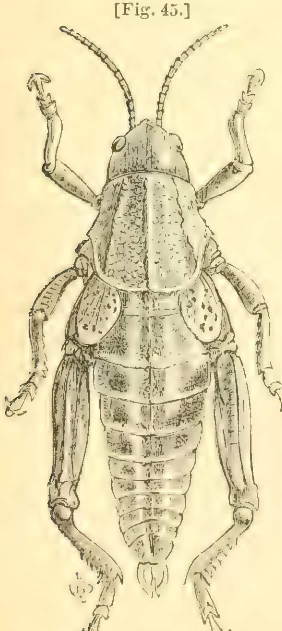
FALSE OPINIONS AND PREDICTIONS.

I have already alluded to the fact that the idea entertained by some people, and particularly promulgated by Mr. Z. S. Ragan, viz.: that our Rocky Mountain Locust comes originally from Asia, *via* Behrings Strait, has no foundation whatever in fact (*ante*, p. 118;) and under this head I desire to reassert and affirm that the belief that the species will continue to move eastward, is just as unfounded. This last belief is more generally entertained than the other, and the following from an editorial in the *St. Louis Republican* of May 25, 1875, is an example of the many expressions of it:

> As near as can be judged from the observations of last year, the grasshoppers do not move more than one hundred and fifty miles during the season. That is to say the hatching locality this year is about one hundred and fifty miles to the eastward of last year's hatching place on an average, and those who have observed their habits think that they will move across the continent at this rate, keeping within a belt of territory bounded generally by the 37th parallel on the south and the 41st on the north. If this theory be correct, they will hatch next year in the counties immediately west of the meridian of St. Louis; the next in the eastern counties of Illinois, the next on the western borders of Ohio and so on.

UNNECESSARY ALARM CAUSED BY OTHER SPECIES.

[Fig. 45.]



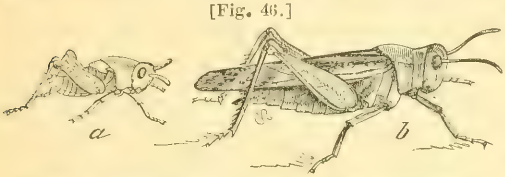
THE CLUMSY LOCUST.

The sense of apprehension of further danger is great in a community that has suffered severely from disaster whatsoever, and locusts which under ordinary circumstances would attract no attention were quite frequently looked upon with alarm and suspicion during the year. Mr. E. W. Kruze, of Sedalia, sent me a very large, short-winged locust found in his locality last Fall, with an inquiry as to its name, and whether there was any connection between its appearance and the late invasion of *spretus*. The same species was also sent from the same locality by Mr. Geo. Husmann. It is the *Brachypeplus magnus* of entomologists, and may be popularly called the Clumsy Locust. It is one of our largest and clumsiest species, incapable of flight, and never doing serious injury. It is common on the plains of west Kansas and Colorado, but has never been reported from Missouri till the present year. It is prettily marked as in Fig. 45, and occurs in two distinct varieties, one in which a bright yellowish-green prevails, and the other in which pale-brown predominates. There can be no connection between its appearance and that of *spretus*, other than that the exodus of this last rendered more conspicuous, all large insects of this kind that were left behind. Reports were circulated and published last February that "the grasshoppers had appeared again at Independence, and in other parts of the State." The following letter from Dr. B. F. Dunkley, of Dunksburg, Pettis county, will show how easily people are misled:

> Inclosed please find some young locusts, just hatched out. We believe them to be the Rocky Mountain locusts, but send them to you to decide. Please answer. In my report, in answer to your circular, I said that some of the locusts that hatched out late and only grew to half the size of others that migrated and left us last July, did lay their eggs, for myself and others saw them at it. Now I think these are from the eggs laid by them. If so, will the cold, when it comes, kill them?

All opinions like those expressed by Mr. Dunkley are based on "mistaken identity." The species noticed hopping about, during the mild weather of January and February, are native species that are with us all the time, and habitually hibernate in the half-grown, unfledged condition. The most common of them, and that sent by Mr. Dunkley and other correspondents, is the Green-striped Locust (*Tragocephala viridifasciata*,) a very common species, ranging from Maine to Florida, and from the Atlantic to Nebraska. It passes the winter in the immature condition, sheltering in meadows and in tufts of grass, and becoming active whenever the weather is mild. It is sometimes found in Winter in the early larva stages but more often in the pupa state, and becomes fledged toward the end of April.

[Fig. 46.]



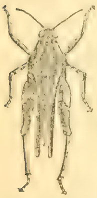
GREEN-STRIPED LOCUST:—*a*, larva; *b*, perfect insect.

It differs generically from the Rocky Mountain Locust, which hibernates in the egg state. This Green-striped Locust, as its name implies, has, when mature, a broad green stripe on the front wings, and in the narrower, humped and keeled thorax or fore-body, (Fig. 46) may at once be distinguished from the dreaded Rocky Mountain pest. Like so many other species of its family it occurs in two well marked varieties, one in which, in addition to the stripe on the front-wings, the whole body and hind thighs, above, are pea-green; the other in which this color gives way to pale-brown. In both varieties the hind wings are smoky with the basal third greenish.

The species noticed by Mr. Dunkley to hatch out late and to lay eggs in the Fall was more probably *femur-rubrum* than *spretus*.

The species of the genus *Tettix* also hibernate in the half-grown and sometimes in the full grown condition, and are frequently supposed to be the young of *spretus*. These insects are very active, and are at once distinguished by the small head, great breadth across the middle of the pro-thorax which extends to a tapering point to or beyond the tip of the abdomen; by the front of the breast forming a projection like a stock-cravat into which to receive the lower part of the head, and by the short, rudimentary, scale-like front wings. They fly with a buzzing noise like a flesh-fly. Our most common species (*Tettix granulata* Scudder, Fig. 47,) may be called the Granulated Grouse-locust. It is like the other species, very variable in color and ornamentation, the prevailing hue being dark-brown beneath and paler above. A well marked variety has a small, pale spot on the rudimentary front wings, and a larger conspicuous one on top of the hind thighs.

[Fig. 47.]



GRANULATED GROUSE LOCUST.

Even insects belonging to a different Order were not unfrequently the cause of unnecessary alarm. In the Spring of 1875 the meadows were reported as being destroyed around Champaign and Jacksonville, Illinois, by what was supposed to be the young of *spretus*; but specimens of these supposed locusts, sent me by Chapin & Simmons, of the *Jacksonville Journal*, proved to be little Jassoid leaf-hoppers allied to the common grape-leaf hopper—insects belonging to a different order (Hemiptera) to that which includes the locusts (Orthoptera.) They were indeed *grass-hoppers*, in the sense of hopping about among the grass, but they were not the so-called grasshoppers (locusts) that were proving such a plague in parts of Kansas and Missouri at the time.

INJURIES OF NATIVE SPECIES IN 1875.

The native species of the genus to which the Rocky Mountain Locust belongs were unusually common and destructive toward Autumn in most parts of the State, except in the region ravaged by that species in the Spring. The Two-striped (Rep. 7, Fig. 34), the Differential (*ibid*, Fig. 33), the Red-legged, (*ibid*, Fig. 26), and the Atlantic species were abundant everywhere, and the two latter were more particularly injurious. These were often supposed to be the genuine *spretus*, and the reports of this last in Jefferson, Franklin and Moniteau counties in the Monthly Report of the Department of Agriculture for November and December, undoubtedly refer to them, and are a sample of the reliability of much of the entomological information that comes through that channel. They were troublesome not only in the Mississippi Valley, but in the East, for I know that they did great damage to oats and meadows in Southwest Pennsylvania, and the following items doubtless refer to the same species, and will show how injurious they were in Massachusetts :

GRASSHOPPERS IN BOSTON. — We did not anticipate that Boston proper would ever be inconvenienced by the pests which have proved so destructive out West, but it is a fact that grasshoppers are so numerous at the South End that they destroy the flowers in the back yards to such an extent that hens are hired or bought to clear the premises and save the ornamental plants which adorn the premises. These insects are not of the Western pattern, but are native productions. If their ravages continue, it is possible some of our Western friends will be called upon to raise subscriptions for the relief of the floriculturists of Boston.—[*Boston Journal.*

I venture to ask your advice in a grasshopper matter. Three years ago a party of farmers and others in this commonwealth, tired of granite hills, gravel banks and sand flats, and wishing some little latent fertility in the original soil—combined to effect, and did effect, the reclamation from the sea of about 1400 acres of what originally was 'salt marsh.' We are amply satisfied of the fertility of this land, and so far, all is good. Last summer, however, this land and adjoining territory was scourged with a plague of locusts or grasshoppers. Whether they came in such numbers owing to the diking of these 1400 acres, or whether they would, last year, have come in equal numbers whether the marsh was diked or not, we cannot say. Our question is this, and is at the same time the point upon which we pray your advice : Can we do anything to diminish the number of these pests for next year? We could, for example, flood this whole tract of land until early spring. Would this be advisable? Any points you would be kind enough to give us on the matter, would be thankfully received.—[Letter from C. Herschel, Boston, Mass., latter part of October.

LOCUST FLIGHTS IN ILLINOIS IN 1875.

The manner in which some writers have clung to the idea that the Rocky Mountain Locust must overrun Missouri, Illinois, and the States to the East, in spite of opposing facts, can only be accounted for by inordinate love of magnifying possible danger and of making as much of a sensation as possible out of any misfortune that befalls a community. A certain amount of apprehension is pardonable ; and that, under such apprehension, all sorts of insects, some of them, as I have just shown, having no relation to locusts, should be mistaken for the Rocky Mountain pest, is natural with persons who have had no acquaintance with it, and are unfamiliar with its appearance. Last September many prominent papers of the West gave the news that the dreaded swarms had finally come into Illinois. In point of fact large swarms of locusts did pass over the central portion of that State early in September, and more particularly over parts of Livingston, McLean, Vermillion, Ford, and Champaign counties. Small and scattered flights were also seen later in the month. Some writers jumped to the conclusion that said swarms were of the Rocky Mountain species, without, however, giving a particle of proof. There is nothing absolutely impossible in the occurrence of scattering swarms of the genuine *spretus* in Illinois the year following a general invasion such as we had in 1874, for while I have expressed the opinion that the species will never do any damage east of the 94th Meridian, I have admitted that it may temporarily extend to some distance beyond that line (7th Rep., 165). But we had no reports of swarms passing over the country to the Northwest or the northwest part of Illinois, prior to their occurrence in the middle counties, and I felt so confident that the swarms were composed of indigenous species, that I so stated my belief in the Chicago *Evening Journal* of September 9th, and expressed the opinion that they had originated within the borders of the State; that there was no occasion for alarm, and that they would scarcely be heard of after they settled. These opinions were subsequently justified by the facts; for after taking every pains to ascertain the truth, all specimens from such flights examined by competent persons proved to be indigenous species. We heard nothing of their ravages or of their rising again and passing over the country to the south or east. Moreover, their flight seems to have been irregular and poorly sustained. Mr. H. P. Beach, County Judge of Ford county, Ills., in sending me specimens, writes, September 15:

About ten days ago myriads of grasshoppers flew southward over town. Many of them came down evidently unable to keep up the journey. They seemed to be all the way from a hundred feet, to a quarter or half a mile high, or perhaps very much higher. In looking up towards the sun—the only way they could be seen,—the appearance was much like that of a snow-storm looked at in the same way. We have not heard from them since, and of course can give you no idea from "whence they cometh and whither they goeth."

Mr. B. F. Johnson, the Champaign (Ills.) correspondent of the *Country Gentleman*, and who has most persisted in believing the swarms to have been composed of the Rocky Mountain species,* also in speaking of these flights, writes to that paper (Sept. 16):

When first seen their movements and motions were so unlike what I had conceived their flights to be, that it was not till several disabled or partially exhausted insects had been caught,and their identity with the Kansas species demonstrated, that I was convinced of their true character. I had supposed that these creatures flew in a manner as pigeons and ducks and geese do—straight ahead in a given direction and with a purpose. On the contrary, every insect seemed to be out on a holiday and acting independently of all the others. While the vast mass slowly moved south with an inclination toward the east, there was a constant circular movement of a vast majority of the whole number of individuals. * * * When it got noised abroad that they were flying, the fact produced a startling sensation. Would they increase in numbers till the sun was darkened and then descend and devour up every green thing, and leave eggs for a progeny behind them that would repeat the disaster next summer? These fears were speedily dispelled when their numbers were seen to diminish, and when it was considered that all the grasshoppers which had passed over, did they come down could make but small impression on the ten thousand square miles of corn in Central Illinois.

Actual examination of specimens from these flying bevies over Illinois, shows them to have been composed of three species, viz: the

* *Country Gentleman*, Sept. 16, 12, Oct. 7, Nov. 11 and Nov. 25. Mr. Johnson cannot be blamed for supposing these flights to have been composed of *spretus*, since considerable experience with this last and some discriminating knowledge are necessary to distinguish it from the common indigenous species, and especially from *Atlanis*. Neither can he be praised for the manner in which he has disdained the evidence in the case; for evading the real question by poor wit (*C. G.*, Nov. 25); nor for suppressing in a controversy in which he challenged my own views, some facts and arguments which I submitted to him by private letter, in answer to his last public communications on the subject.

Red-legged, the Atlantic and the Differential locusts: in no instance was a specimen of *spretus* seen. The several specimens obtained from Ford county were all *Atlanis;* a single specimen received from Mr. H. J. Dunlap, of Champaign, was a male *femur rubrum*, while specimens taken by Prof. Burrill, of the Industrial University, at the same place, as well as others from Norwood, Mercer county, sent to Prof. Thomas, were *differentialis*. The parties capturing these specimens are not apt to fall into error, and are all positive that the specimens submitted were from the flying bevies.

From these facts it results that two species, viz: *femur-rubrum* and *differentialis*, though normally having no migratory habit, and, as I believe, incapable of extended flights, can actually assist in such flights. That the bulk of these Illinois swarms was composed, however, of *Atlanis*, scarcely admits of a doubt. The other two, less able to sustain lengthened flight, would naturally be most near the ground and most often captured; while *Atlanis*, which we now know to occur in this part of the country as well as East, and to often display the migratory habit, would fly higher.

There are two facts which it will be well to bear in mind in this connection, as explaining the above phenomena. The first is that, as we have already seen, *Atlanis* was very common in Missouri, even in fields where it had never been noticed before. It prevailed to such an extent in Illinois, that around Carbondale, Prof. Thomas could not find a single specimen of the typical *femur-rubrum*, and there was not a single specimen of it among a number which he caused to be collected for me. So obvious was this fact that Prof. Thomas was led to suggest in the Chicago *Inter-Ocean* of October 9, 1875, that the one was the out-growth of the other. I quote his language:

This species (*femur-rubrum*) which can usually be found anywhere in the fields or along the roadside during the Summer and Fall, appears to be entirely replaced by a new form, which I take to be the one described by Prof. Riley as *Caloptenus Atlanis* which is an intermediate form between C *femur-rubrum* and *C. spretus*, so near, in fact, to the latter that it is almost impossible to distinguish the one from the other. I have searched in vain for *femur rubrum*, it seems to have entirely disappeared, and that the new variety has taken its place. Is the one the progenitor of the other: the former of the latter? I am no believer in Darwinianism, but here is presented a problem difficult to solve, unless we admit the correctness of that theory, or, that all three supposed species are but varieties of one, which I am half-way inclined to believe is the case. Otherwise how are we to account for the appearance of this new form this season? The *spretus* has not visited our section, the *femur-rubrum* is absent, and here I have before me a large number of specimens gathered here, some of them to-day, with the long wings and the notched male abdomen, corresponding exactly to Professor Riley's description of *Caloptenus Atlanis?* Is the common *femur rubrum* being transformed into *spretus*, this being the intermediate step? If so, over half the distance has already been traversed.

The second fact is, that *differentialis* was also unusually abundant. A letter from Mr. M. Brinkerhoff, of Onarga, Illinois, dated October 18, 1875, and accompanied by specimens, describes them as in great numbers there, filling the ground with their eggs.* The following which refers to the same species is also interesting:

While the migrating hopper committed such devastation west of us, we here at Bluffton have the manor-born, in immense numbers. A patch of potatoes, and some sweet corn, seemed in danger of being consumed, when a flock of purple grackles, our crow blackbird as it is usually called, came to our rescue. The few days that they have visited the patch, has thinned out the hoppers amazingly. I never before noticed that this bird was so useful in this respect, and as they are plenty, we may expect to be rid of the big grey fellows (hoppers). They are more than twice the size of the Colorado hopper, and are nearly as bad on a crop when plenty. What saved our little crop from utter destruction, was an open field of land thickly covered with wild chamomile, upon which they fairly swarmed. On this we saw them as thick as the Colorados, in Sedalia or Warrensburg.—[S. Miller, in *Rural World*, Aug. 14, 1875.

Though unusually common, yet *differentialis*, if I may judge from my own experience in our fields and around Chicago, last Fall, compared only as 1 to 50 with *Atlanis*, and it is doubtful if it formed a larger proportion of the flights. How are these exceptional migrations of local species to be explained? We know they have occurred at intervals in the East, (7th Report pp., 167–171) and we now have evidence that they may occur in any part of the country; and indeed local swarms were not confined to Illinois last Fall as they were also noticed in Kentucky. I think the explanation is simple. The excessively hot dry years of 1873 and 1874 permitted the undue multiplication of these native species, and they were already very troublesome in the latter year (7th report, p. 173.) The myriads that hatched out in 1875 were scarcely noticed at first and made little impression on the luxuriant vegetation that a wet and favorable season produced. By September, when a spell of dry weather cured the grass and the locusts had acquired full growth, we can imagine that they swarmed in much of the prairie country of Central Illinois. Whenever they abound to an unusual degree the migrating instinct is developed, just as it is under like circumstances in many other insects, as butterflies and beetles, that are normally non-migratory. The reasons we can only surmise; but aside from those of hunger, etc., previously suggested (Report 7, p. 164), the annoyance and inconvenience to which the females while attempting to oviposit, have to submit from their companions, under conditions of excessive increase, may have something to do with it. But mere increase in numbers would not give to species like *femur-rubrum* and *differentialis*, which

*The eggs of *Caloptenus differentialis* may be distinguished from those of *spretus* by the larger and more irregular size of the mass; by the greater number composing it; by the somewhat larger size of the individual egg which measures 0.19—0.22 inch in length; by the coarser reticulations of the shell, and by the brown color of the gummy fibrous matter that is intermixed with them and glues them together. The color of the egg varies from yellow to deep carneous, the latter prevailing, and the posterior or narrower end is always somewhat constricted and darker.

are ordinarily heavy-bodied and short winged, the power of extended flight, and there is little doubt, in my mind, that the same exceptionally hot, dry seasons which permit this undue multiplication, also modify the individuals, and cause a decrease in bulk and increase in wing-power. The facts support this view, for the flying specimens of *differentialis* sent to Prof. Thomas had, as he writes me, "the body lighter and the wings longer, and some of that peculiar fierce appearance belonging to migrating specimens;" and I have specimens from Kansas and Minnesota which differ so much in these respects from the more normal specimens as found with us in ordinary seasons, that they can scarcely be recognized as the same species. The casual observer knows how thoroughly plants are modified in size and habit by season and condition: the same holds true of insects, and more particularly in certain groups.

Given that over the vast prairie region of Central Illinois, the insects were as thick as I found them in many of our own fields, where every step would cause two or three hundred to rise, and let this migratory instinct be developed, and the mystery of the Illinois flights vanishes. They are exceptional local phenomena: they are neither as strong nor as long sustained as those of the Rocky Mountain species; nor are they in any sense to be as much dreaded.

In short, whenever the climate and conditions in the Mississippi Valley approach those existing in the native home of the Rocky Mountain Locust, some of our native species, and especially those nearest akin to it, also approach it in habit. If the climate of Illinois and Missouri were to permanently change in that direction, these species would become permanently modified; but as there is no immediate danger of such a contingency, the Rocky Mountain Locust is the only species, here considered, that can properly lay claim to the migratory habit.

PROSPECTS IN 1876.

The people in our western counties are very naturally quite interested in the locust prospects during the coming year; the more so that the story has been widely circulated that the danger was greater than ever before. As an example I take the following from an editorial in the St. Louis *Globe-Democrat* of the 26th of December last:

> Persons whose experience in such matters entitles their opinions to respectful consideration, declare that the Summer sun of 1876 will hatch such swarms of grasshoppers in the West as have never before been seen, and that the tract of country in which they will prevail will be wider than ever before, reaching from a long distance west of the Black Hills to the center of Missouri and Iowa.

I know of no persons whose experience deserves respectful consideration who have declared anything of the sort; and so opposed to the facts is the declaration that I do not hesitate to state that there is no possible danger of any general injury in Missouri this Spring, and no probable danger in the Fall; and to convey my views more fully I reproduce a short article which I last January communicated to the *New York Tribune:*

Some one has announced the fact that there has been a prodigious number of locust eggs laid all over the nothwest portion of the country lying east of the Rocky Mountains. Some one has asserted that the soil of Wyoming, Montana and Dakota is generally and thickly charged with these eggs. Who this some one is with such vast experience that he has examined the soil over such large areas as to make the statement, nobody knows. But some careless editor has set the gossip's ball in motion, and it has rolled on from paper to paper, with one change and another, until at last the Boston *Journal* includes Missouri, Kansas and Nebraska in its portentous scope. "Observations show," says this journal, "that last year's grasshoppers deposited immense numbers of eggs, and when the warm weather comes and hatches them, devastation even more than these sections have previously known, will be pretty sure to follow." "Observations show" that some editors are very gullible, and too ready to propagate the sensational, and to disseminate alarming statements on the flimsiest grounds. They publish as fact the veriest *on dit*, without once inquiring into its probability or caring for the consequences.

From personal observation in parts of Missouri and Kansas, and from an extensive correspondence, I am able to say that such statements, so far as these two States are concerned, are entirely groundless; and I have every reason to believe that the same will hold true of Nebraska; while in Minnesota, the investigations of the commission appointed last summer by the Governor, indicate that even where eggs were laid in that State, they mostly perished from excess of moisture, which dissolved the glutinous substance which normally protects and holds them together. That in some parts of the high country lying east of the mountains, especially toward the North, eggs have been deposited in numbers, is not only probable but pretty certain. But in that region such is the case every year, for it is the native home of the swarms which occasionally extend to the upper Mississippi valley. But the number of eggs laid in the States of Missouri, Kansas and Nebraska by the few straggling insects that passed into that country last Fall, will not equal that laid in ordinary seasons by indigenous species. In Colorado, also, there have been in most parts such abundant rains since locust eggs were laid, and the ground has been so unusually moist, that there is some hope that the bulk of the eggs are or will be destroyed.*

I give it as my belief that, first in the three States mentioned, (Missouri, Kansas and Nebraska), there will not hatch as many locusts next Spring as would naturally hatch in ordinary seasons from the indigenous species; second, that, compared with other parts of the country, those States ravaged by locusts last Spring and early Summer will enjoy the greater immunity, during the same seasons of 1876, not only from locust injuries, but from the injuries of most other noxious insects, except the wood-borers. In short, the people of the ravaged section have reason to be hopeful rather than gloomy. They will certainly not suffer in any general way from locust injuries in the early season; and the only way in which they can suffer from the migrating pest is by fresh swarms later in the year from the far northwest, the odds being, however, from a number of reasons which it is unnecessary to enumerate here, very great against any such contingency. There is one redeeming feature in the *Journal's* article. It is the advice to the people of the States named to not be profligate of the abundant corn crop they have garnered, but to store it for an emergency. If nothing short of a false alarm would cause them to do this, the statement might find justification; but the lesson of 1875 so clearly pointed to such a course, and was so dearly bought, that it will not needlessly go unheeded.

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* The *Colorado Farmer* for April 28, 1876, says editorially: "Hearing many conflicting reports about the probable appearance and ravages of the hoppers this season, we took time recently to visit a number of ranches on Clear Creek, Ralston and Bear creeks, and investigated for ourselves and interviewed many, and from all the inquiries we have made of reliable people from all parts of the Territory and a careful gleaning of our exchanges, we have been lead to the following conclusions:

There will be some locusts, but not in the countless millions of last year. They may do some damage, but not such havoc as in the past. They have already commenced to hatch in warm, sunny localities, and a careful examination of the ground in many places miles apart, and in different sections of the oountry and their favorite hatching grounds demonstrates that the eggs are in insignificant quantities compared with last near, and that where farmers have worked to exterminate them by dragging the ground several times during the Fall and early Winter and Spring, millions of eggs have been destroyed.

THE GRAPE PHYLLOXERA.

This insect still continues to attract much attention abroad as well as at home. Owing to the excessively wet summer of 1875 it did comparatively little injury in our own vineyards, and I have little to add to what has been previously published in these Reports.

COMPLETION OF ITS NATURAL HISTORY.

Having shown last year that our knowledge of the natural history of this insect was then all but completed, it gives me pleasure to now record its completion, which I can best do by supplementing with a few additional notes the following paper read last October before the St. Louis Academy of Science:

It is well known to those who have followed the habits of *Phylloxera vastatrix*, as these have been discovered and recorded, that one of the most important points in the life-history of this insect that has hitherto remained unsettled, is the nidus which the winged female chooses for the consignment of the few eggs she lays. In 1871 I ventured the supposition that these eggs were deposited in the down of the leaf-buds,* but subsequent observation led me to believe that "the more tomentose portions of the vine, such as the bud, or the base of a leaf-stem, furnish the most appropriate and desirable *nidi*" for these winged mothers, and that the eggs were also laid in minute crevices on the surface of the ground, especially around the base of the vine†—all these conclusions being based on observations made on the insects in confinement. The question is an important one practically, as the hope was entertained that, by knowing just where to look for these eggs, we might be able to check the rapid spread of the Phylloxera disease, since it is through them alone that the disease can be started in new localities distant from infested regions. Feeling, from past experience, that it was extremely difficult to solve the problem in the open vineyard, and that experiments with the insect confined in tubes were more or less unsatisfactory, I built, early in September, a tight house of heavy Swiss muslin, six feet high and four feet square, over a Clinton vine. The house was built so as not to permit even so small an insect as the winged Phylloxera to get in or out, and the vine was trimmed so that but few branches and leaves remained to be examined. Into this enclosure I brought an abundance of infested roots, and for the past five or six weeks I have been getting the winged females confined where I could watch their ways. In addition, I prepared large, wide-mouthed glass jars, by half filling with moist earth. Into the earth was then stuck a vial of water holding a tender grape-sprig with young leaves. The leaves were thus easily kept fresh and growing for a fortnight and upward. From day to day, as the winged females were obtained from other vessels prepared for the purpose with infested roots, they were introduced into these jars containing living leaves.

The results of these endeavors to supply the winged mothers as nearly as possible with the natural conditions have been satisfactory, and they prove that, as was surmised, the eggs are laid in crevices of the ground around the base of the vine, but still more often on the leaves, attached generally by one end amid the natural pubescence, or rather down, of the under surface; and while heretofore all efforts to artificially hatch

* Fourth Mo. Ent. Rep., p. 65.

† Seventh Mo. Ent. Rep., p. 98.

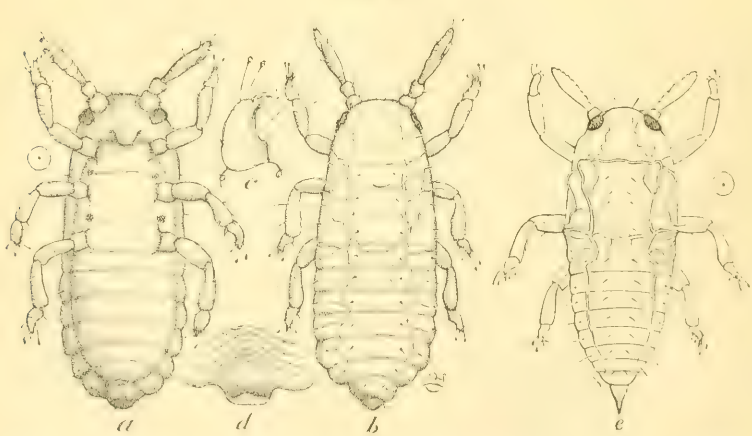
the progeny from these eggs have, for the most part, failed, I have this year succeeded in hatching them without difficulty, and present a tube with living individuals, and also mounted specimens for the inspection of members. I have also succeeded in getting both sexes of the American Oak Phylloxera and in thus completing the natural history of both species.

Though this true sexual form of *vastatrix*, from the winged and agamous female, has never before been carefully observed and described, it was nevertheless anticipated by Balbiani in his studies of the European Oak Phylloxera (*Phylloxera quercus* Fonsc.) and by myself in my studies of the American Oak species (*P. Rileyi*).* Balbiani had also obtained what is evidently the same from eggs deposited by wingless, hypogean mothers late in the season and after the winged mothers cease to fly.†

The winged females carry in the abdomen from three to five and sometimes as many as eight eggs. These eggs are of two sizes—the smaller, which produce males, about three-fourths the size of the larger, which produce females. As the whole organization of these aërial mothers—with the stout proboscis and ample wings—indicates, freedom and nourishment are needed to bring the eggs to perfection and cause their proper oviposition. In confinement in small vessels, where these requisites are not easily furnished, the eggs are generally voided, with the death of the parent, on the sides of such vessels; and those freely laid are with the greatest difficulty brought to the hatching point. Only in two instances did I succeed in doing this last year. These failures in the past find their explanation not so much in the difficulty of supplying the natural conditions, as in lack of experience as to what those conditions were.

Whether owing to the want of down on the Clinton leaf, or to the fact that the minuteness of the eggs makes it about as difficult to find them on a square four feet of earth surface as the proverbial "needle in a haystack," the eggs found on the vine in the aforementioned muslin enclosure were very few compared to the number of winged insects which must have come out of the ground. It was also next to impossible to

[Fig. 48.]



SEXED PHYLLOXERÆ:—*a*, female *vastatrix*, ventral view, showing egg through transparent skin; *b*, do, dorsal view; *c*, greatly enlarged tarsus; *d*, shrunken anal joints as they appear after oviposition; *e*, male *caryæcaulis*, dorsal view—the dots in circle indicating natural size.

* Seventh Mo. Ent. Rep., p. 119.

† *Comptes Rendus de l'Acad des Sc.*, Paris, Nov. 2, 1874.

find, and quite impossible to follow, the sexed individuals after hatching. In the prepared jars, where the tomentose leaves of *Labrusca* were kept, I obtained more satisfactory results; for, while a few eggs were laid on the surface of the ground, especially in the space between the earth and the glass, and a few others on the upper side of the leaves, by far the larger number were attached to the under surface, generally by one end and thrust between the natural down of the leaf—evidently showing that this is the natural nidus chosen. The winged mothers die soon after ovipositing, and their shrivelled and decaying bodies adhere to the leaf-down.

By taking a leaf bearing eggs that are eight or nine days old and enclosing it in a smaller, tightly corked tube, the sexed individuals hatch freely, and are easily watched. This hatching takes place on about the tenth day after deposition, with our late September temperature. The egg perceptibly enlarges during this time, a fact that might be explained by endosmosis of the leaf-juices were it not known that the same fact holds true of many soft insect eggs that are not attached to succulent leaves or other living vegetation. The red eyes are seen through the delicate egg-shell early in the development of the embryon, and just before hatching the joints of the body are perceptible. The egg-shell is so delicate that in the process of hatching it is usually pushed back in folds, and is left as a little wrinkled, whitish mass: occasionally, however, it more nearly retains its original form.

The sexed individuals are at once distinguished from all the other forms which this interesting species assumes by the obsolete mouth-parts, the sexual organs and the more highly developed nervous system: otherwise, in size, in smoothness and in obsoleteness of the basal joint of tarsus, they most closely resemble the newly hatched larva.

The female (Fig. 48, *a*, *b*) measures 0.40 mm, and is about one-third as broad. The body widens slightly behind, and the two narrow anal joints of the abdomen swell out prominently from the others. A mere swelling between the two anterior coxæ represents the mouth-parts. The antennæ more nearly resemble those of the wingless, agamous ♀ than of the winged one, having but one rather small plate near the end of the third joint, which third joint is generally constricted at base so as to give it a somewhat more pedunculate appearance than in the other forms; this does not always appear, however, as in some of my mounted specimens the diameter of the joint from base to tip is nearly uniform. The minute, black, dorsal, hair-like points, as also the dusky subventral warts each side of sternum just outside the coxæ, are visible as in the agamous ♀, but not the six pale medio-sternal tubercles between the legs. The legs have the tibiæ rather heavy terminally, and the tarsi show no distinct basal joint: they otherwise precisely resemble those of the agamous ♀, and are, together with the antennæ, similarly more dusky than the body. In most of my mounted and transparent specimens (9 examined), two irregularly contorted nervous chords with numerous finer ramifications are distinctly visible, one each side, crossing and joining on the prothorax and metathorax.

The male differs in no respect from the female, except in the bulbous penis tapering to a point; in broadening, if anything, before rather than behind, and in being about one-fourth smaller. Barring the somewhat shorter black points, he is the counterpart of the same sex in a larger species (*caryæcaulis*) which I have already illustrated and the figure of which I here introduce (Fig. 48, *e*.)

The single egg which the true female carries develops rapidly after she is born, and on the second day already occupies nearly the whole body, as shown at Fig. 48, *a*. It is delivered the third or fourth day, and this generally happens independent of impregnation.

This impregnated egg, which I have so far obtained only in my small tubes, is smooth like the other eggs of the species, but more elongated or ellipsoidal, and but very slightly broadest behind. It measures 0.32 mm., and is nearly three times as long as broad. Bright yellow when laid, it soon acquires a deeper, yellowish-green color. The posterior end is generally thickened or roughened by what is probably a mucous secretion that serves to attach it.

Where this egg is naturally laid I have not yet ascertained, but in all probability it is carried into or near the ground by the impregnated parent. The young hatching from it is the normal agamous female; for, though I have not yet hatched this impregnated egg of *vastatrix*, I have succeeded in doing so with that of *Rileyi*, and Balbiani long since did so with that of *quercus*. I am led to think that, once impregnated, the female carries her egg into the ground, because in 1873 I found females whose abdomens, instead of being filled with numerous small eggs, were distended with a single large one;* and, though I was puzzled to interpret the fact at the time, I have no doubt now that I then had under my eyes the true, impregnated female here described, and that I overlooked the obsolete mouth.

The habits of these sexed individuals, as I have been able to observe in both the Grape and American Oak species, are similar to those recorded by Balbiani of the European Oak species. The male is quite ardent, more active than the female and somewhat longer-lived.

The complete natural history of the Grape Phylloxera may now be considered established. A full biological view of the species exhibits to us no less than five different kinds of eggs: 1st, the regularly ovoid egg, 0.25 mm. long and half that in diameter, of the normal, agamic and apterous female, as it is found upon the roots; 2d, the similar, but somewhat smaller egg of the gall-inhabiting mother; 3rd, the ♀ egg from the winged mother, rather more ellipsoidal, and 0.50 mm. long when mature; 4th, the ♂ egg from same, ¼ less in length and rather stouter; 5th, the impregnated egg, just described, 0.32 mm. long and still more ellipsoidal. We have also the singular spectacle of an egg from the winged mother increasing from 0.34 mm. (its size when laid) to 0.40 mm. (its size just before hatching;) giving birth to a perfect insect 0.40 mm. long, and this in turn, without any nourishment, laying an egg 0.32 mm. long. A being is thus born, and, without food whatsoever, lays an egg very nearly as large as that from which she came.

From observations here recorded I would draw the following conclusions:

1. We can no longer entertain the hope of any practical good from the knowledge of the nidus chosen by the winged mothers, as the destruction either of these or of their eggs—scattered as they are on the leaves all through a vineyard—is out of the question. The objects are too small to be practically searched for, and it is virtually impossible to prevent the spread of the disease in this stage. We might almost as well try to prevent mildew by the destruction of the invisible floating spores that must at times pervade the atmosphere of a vineyard. The hope entertained by Lichenstein that the winged mothers would congregate and be attracted to some particular plant must, I think, be abandoned.

2. The only preference shown in this respect would seem to be for those leaves that are most downy or tomentose; and from this view of the case we get another probable reason why the varieties of Lubrusca which are characterized by an abundant downiness on the under surface of the leaves suffer most from the insect.

3. Having already had the young from the impregnated egg of *Rileyi* hatch in about a fortnight after it was laid; having shown in previous writings that this species winters in the larva state, and not in the impregnated egg as does the European *quercus*; and, remembering, further, that *vastatrix* resembles *Rileyi* in wintering as

* One fact, which is not now interpretable, but may have a significance in future, I feel constrained to record in this connection. It is that, in examining *vastatrix*, I have occasionally met with degraded ♀'s (underground mothers) in which the abdomen, instead of containing numerous small ova, was well nigh filled with a single, much larger, egg. Every observed fact leads to others yet unknown and unsuspected; and the full history of Phylloxera has yet to be written.—6th Rep., p. 87.

larva, it is safe to conclude that the impregnated egg of *vastatrix* will also hatch the same season that it is laid, and that we cannot apply to it the term "winter egg" which Balbiani applies to the impregnated egg of *quercus*. It is not unlikely that, since a few of the winged females issue as late even as the latter part of October, some few also of the later produced impregnated eggs may pass the winter unhatched; if so, they may be considered exceptions to the rule. In the same way, a few of the more common eggs from the agamous ♀ may be exceptionally found on the roots in winter, though as a rule only the hibernal larva is found.

In conclusion, I would state that this year's studies of both *vastatrix* and *Rileyi* confirm me in the opinion, elsewhere maintained (7th Rep. p. 91), that the term "pupa," as applied to the sexed eggs by Lichtenstein, is quite unwarranted, and that the egg-covering—thin and plastic though it is—can in no sense be likened to a cocoon, and still less to a "silken cover." The fact of its shriveling up makes it none the less an egg-shell, for this shriveling process occurs in all eggs with very delicate and plastic covering, and may, indeed, be witnessed in the gall-inhabiting form of *vastatrix*, though no one has thought of questioning the ovarian nature of the eggs found in those galls.

My sincere thanks are due to Miss M. E. Murtfeldt, who has carefully carried on observations for me during my necessary absence. Without her patient watching and persevering efforts, my endeavors must have measurably failed of results.

Soon after the above paper was printed, I received one by Balbiani, published October 4,* in which he announces having also discovered the nidus which the winged females choose, and obtained the solitary impregnated egg of *vastatrix*. Lichtenstein also about the same time succeeded in obtaining the sexed individuals and the solitary egg, at Montpellier. The same observations were thus being made simultaneously by three parties, both in Europe and America. The few eggs which I obtained in my tubes became discolored and perished, perhaps from not being impregnated, and I can make little out of them under the microscope. Balbiani, by the assistance of M. Boiteau of Villegouge (Gironde) was able to make his observations in the open vineyard. He has been more fortunate and assiduous than myself in continuing them, and has, as I just learn while writing this, obtained the progeny from the impregnated egg. It is evident, also, that with his trained eyes and excellent instruments, he sees minute details which escape the notice of others, and I lay before the reader the results of his observations.

The eggs of the winged female are not only placed on the under side of the leaves amid the natural down, but also beneath the loosened bark of branch and trunk, and in the recesses afforded by the buds. As my friend Lichtenstein found them laid on muslin with which he confined winged mothers, it would seem that they may be laid almost anywhere. Nevertheless I am satisfied that the leaves

*Comptes rendus de l. Ac. d. Sc., Paris, Oct. 4, 1875.

form the most natural and most favorable nidi. Balbiani describes the impregnated egg in detail as 0.28 mm. long and 0.13 wide, and as mine were somewhat longer they probably vary slightly in size. It gradually acquires an olive green tint, speckled with minute darker dots. It is polished, translucent, and the shell is finely reticulate with hexagonal meshes. This egg is always laid on the more solid and permanent parts of the vine under the bark that is becoming loose. It remains in these positions during the winter and with the renewal of vine growth in Spring gives birth, as from analogy we knew it would do, to the wingless mother louse which starts anew the virginal reproduction. In all essential characters it is like the normal root-inhabiting, wingless, virginal mother, but is intermediate in size and form between this last and the true sexual female when compared at the moment of hatching. Balbiani gives the length as 0.42 mm. and the width 0.16 mm.

The habits of this mother which, with increased vitality starts the somewhat complicated cycle of the species' changes, have not yet been observed, but she doubtless seeks the roots to there surround herself with eggs, resting no doubt for the most part just at the butt of the vine; while an occasional individual, where the conditions are favorable, may settle on a tender leaf, and found the gall-inhabiting type.

These observations of Balbiani's establish one thing, which is, that the impregnated egg hibernates before hatching, and they would seem to indicate that the third conclusion which I drew (p. 161) is erroneous. But I yet strongly incline to believe that further observations will prove that, as there suggested, the hibernation of the impregnated eggs will prove exceptional and that they mostly hatch the same year that they are laid. The eggs which I obtained having failed, and feeling much interest in verifying in this country the interesting discoveries made by Balbiani in France, I have perseveringly sought for the impregnated egg in our own vineyards the past winter. I have most carefully examined many a vine from "top to stern" myself, and have employed Mr. Theo. Pergandy, who is well trained in the examination of minute objects, during nearly every mild day to inspect vines in vineyards in which I knew the Phylloxera to occur. I have had whole vines dug up from the Bushberg vineyards, and collected large quantities of the loose bark for careful examination and inspection in-doors; and while I have been rewarded by some interesting discoveries, and have obtained the eggs of a large number of other insects, I have failed to find the first Phylloxera egg, though in several instances I have found what may be the empty shell. This failure to find here what has been found in France, may be due to the comparative scarcity of the insect with us in 1875, and while I would by no means conclude from it that there is any difference of habit in the insect here and there, it shows how very rare these winter eggs may sometimes be.

PRACTICAL CONSIDERATIONS GROWING OUT OF THESE LATEST DISCOVERIES.

Since the announcement that the impregnated egg winters under the loose bark, a number of French writers have proposed plans for its destruction, and urged that such was the readiest way to avert Phylloxera injuries. The plans mostly consist of the decortication of the vines and burning of the bark, and the application to the wood of some oily liquid such as kerosene, that may be applied so as to penetrate and destroy the egg and not injure the wood. While granting that the destruction of such eggs in such manner is desirable, especially in a vineyard in an infested neighborhood, but not yet suffering, I doubt whether it is sufficiently important to warrant the labor involved; for those who advocate such a preventive system most earnestly, forget that by far the larger number of the insects hibernate as young larvæ on the roots, and that according to Balbiani this same impregnated egg may be produced on the roots from sexed individuals born of hypogean, wingless mothers.

While it is always best to know the truth, in the present instance it certainly does not give us any advantage over our enemy. Now that we have obtained a full survey of his powers we find no especial weak point by attacking which he can be destroyed. He has too many resources at command. From the practical side it seems to me that the lessons taught by these late discoveries are more discouraging than otherwise. There is no chance of managing in any general way the destruction of the eggs on the leaves, and it is evident now that the insect may be imported from one country to another on cuttings as well as on rooted plants; and that winter submergence will not eradicate the pest. We furthermore get a better understanding of the fact that in so few instances the insect has been eradicated by insecticides applied to the soil. One valuable lesson is taught by these facts: it is that the season in which insecticides applied to the roots will do most good, is in the interval between the hatching of the impregnated winter egg and the appearance of the winged females, i. e., during May and June.

PHYLLOXERA RAVAGES IN CALIFORNIA.

There is no longer any doubt whatever of the occurrence of Phylloxera in California. It has during the year made its presence but too manifest around Sonoma, and many vineyards there are already seriously affected. Mr. Julius Dresel of that place, who was in my office the past winter, informed me that he has himself had to root up many hundreds of vines, and that the roots are crowded with the lice. There naturally exists much excitement among the grape-growers of the Pacific about it. Had the subject not been thought too lightly of and had the California authorities taken some steps to guard against the introduction of the pest when I pointed out the danger in the Fall of 1871 in the *Rural New Yorker* and *Rural World*, and also in my 4th Report (p. 56), the calamity which now seems inevitable to their grape interest might have been averted. Active measures, even at this late day may do much good, but it seems impossible to get our politicians to appreciate the interests of the producing classes. A bill "for the destruction of the Phylloxera" was introduced at the last session of the Legislature which, through indifference, failed to pass; and it is probable that nothing will be done till bitter experience obliges action, by which time it will in all probability be useless. While the authorities fail to appreciate the situation, the grape-growers are much exercised, and are already endeavoring to profit as much as possible by the researches of others, and the experience of the French. This they will be able to do through the efforts of Prof. E. W. Hilgard, of the University of California, who appreciates the situation and who, in an address, delivered before the State Vinicultural Association, at San Francisco last November, gave an excellent resume of the insect's habits and of the best means of managing it. He infers that, from the great local intensity and comparatively slow spread of the disease, the winged females are not developed to the same extent as in France or the Mississippi Valley—an inference which, it is to be hoped, future experience may warrant, but which I fear it will not.

ITS OCCURRENCE IN THE SOUTHERN STATES.

While I have shown in previous Reports that the Phylloxera actually occurs in North Carolina and other Southern States, the examinations made by Messrs. Berckmans and Ravenel, at Augusta, Ga., and Aiken, S. C., which I reported last year, indicate that it is not found in those localities. In the Proceedings of the 15th Session of the American Pomological Society is a report of a special committee, consisting of A. S. Fuller, of N. J., Messrs. Berckmans and Ravenel, and Thos. Taylor, of Washington, D. C., appointed at the previous meeting of the society upon the following resolutions offered by Mr. Berckmans, and which indicate the object of the mover:

"*Whereas*, American vine-growers are accused in the south of France of having introduced there the *Phylloxera vastatrix or Gall Louse*, which is now causing the destruction of thousands of acres of vineyards, it is due to them that this assertion be removed; it is, therefore,

"*Resolved*, That a committee be appointed to fully investigate its origin, whether American or imported, the amount of destruction caused here, its area of dissemination, etc.

"The committee to report the results of their labors in the Proceedings of the present session."

The report was not submitted for discussion at Chicago, which is to be regretted, as it is a very partial and one-sided statement of the facts. It consists of some general statements by the chairman, of the examinations made in 1874 by Messrs. Berckmans and Ravenel, and published by me last year, and of additional examinations made by the same parties in the same localities in 1875, and which, as embodying the only facts in the report, I republish herewith:

Examinations made by Mr. Ravenel in 1875.

June 5th.—Made an examination to-day of 2 Isabellas, 1 Warren, and 1 black July vines, for Grape Phylloxera; found nothing.

June 11th.—Examined at Mr. Cornish's vineyard, 1 Muscat, of Alexandria, 1 Chasselas, 1 Catawba, 1 Isabella, 1 Black July, and 1 Warren; could find no traces of insect life; roots, both young and old, perfectly healthy.

June 15.—Examined the following grape-vines at Mr. Scheveiren's vineyard, situated in the lower part of Aiken, 1 Isabella, 1 Catawba, 1 Delaware, 1 Clinton, 1 Concord, 1 Riesling, and 1 Chasselas. These vines are about 8 years old, (except the last which were only 2,) healthy and vigorous, and in fine fruit; we could find no traces of insect life. The young and older roots were clean and healthy, and showed no ravages in previous years.

July 8th.—Went over to Mr. Berckmans' Fruitland Nursery, near Augusta, Georgia, and made examination of the following vines:

1 Clinton, 2 years old, under cultivation.
1 Clinton, 3 years old, under cultivation.
1 Ives, 4 years old, under cultivation.
1 Concord, 4 years old, under cultivation.
1 Taylor, 5 years old, not cultivated one year.

I could find no trace whatever of insect life.

The roots of young and old are healthy, and exhibit no effects of former ravages.

The above are transcripts from my notes taken at the time the examinations were made. In the two seasons I have examined 60 specimens, comprised in 18 different varieties of grapes, and in four separate localities. The soils of these four localities vary from a light and loose sandy soil (my own, on the borders of the "sandhill" region,) to a firmer and more compact (Scheveiren's in the lower part of Aiken,) and a clay loam (Dr. Berckmans' in Georgia.)

I present the above facts as they have come under my own observation. I used in all these examinations a pocket glass of high magnifying power, and saw nothing which I considered necessary to be put under the microscope. Had the insect been present in any form, either as egg or living animal, I could not have failed to detect it.

Examinations made by Mr. Berckmans in 1875.

June 5th, 1875.—At Redcliffe, South Carolina, the residence of Harry Hammond, Esq., examined Pauline, Black July, Warren, White Chasselas, several varieties of Muscat and Malvaisia, soil a very stiff red clay, very compact; vines planted in 1859-60; cultivated three or four years, then abandoned; no culture for eight years, during which time vines were much injured by wagons running over them; ground plowed and vines received a working in the winter of 1874-75, the first in ten years. Growth luxuriant and most healthy, some of the foreign vines having canes of the new growth from four to seven feet; fruit scattering, but healthy; no trace of Phylloxera. N. B. The foreign vines are on their own roots.

August 12th.—Received to-day from Mr. Hammond, thoroughly ripe and perfect bunches of Chasselas from above vines. Wood and foliage perfect, notwithstanding most unusually hot and dry month of July.

June 7th, 1875.—Examined at Sandhills, Augusta, Concord, Ives, Gœthe, Wilder, Lindley, Maxatawney, Eumelan, Cynthiana, Brant, Cornucopia, Canada, Senasqua, Croton, Catawba, Warren; vines from two to seven years old; soil almost pure sand, kept well cultivated and fertilized with annual top dressings of bone-dust and leaf-mould; growth moderate in most varieties, owing to vines being closely planted and defective pruning; not a trace of insects. This vineyard is now yielding a heavy crop of perfect fruit.

July 30th—Examined a vineyard of a little more than one acre; vines trellised and kept in cultivation annually; vines four, six and eight years old. Catawba, Concord, Delaware, Diana, Wilder, Lindley; soil a compact whitish clay subsoil, commonly termed here crawfish land; top soil sandy; situation very low, and soil retentive of humidity, but well drained; vines very luxuriant; fruit abundant, sound and not a trace of Phylloxera.

August 10th—Dug up to-day a vine of White Chasselas, planted in 1858; vine was injured several times and repeatedly broken; first growth of the year was broken off when it had attained six feet; grew off vigorously, and set fruit on second growth; canes of latter six feet, very vigorous and healthy, and after submitting the rootlets to close investigation, failed to find a trace of insect; soil a rich, gravelly loam, two feet deep, and subsoil stiff, red clay.

From these notes it is evident that the presence of the Phylloxera is still unknown here; the vines examined at Sandhills had been received from various sources, north and west. Mr. Hammond's foreign vines were brought by him from the garden of the Luxembourg, Paris, in 1859. My foreign vines, of which I cultivated, in 1860–61, nearly 400 varieties, came from various sources; some from Paris, Angers, Nice, Hungary, Crimea, and a large portion from Algeria. Not a trace of Phylloxera has ever been discovered on any of them.

These reports are most interesting, and while they confirm the absence of Phylloxera in the vineyards examined, they also most eloquently support the views so repeatedly urged in my writings. Where the Phylloxera occurs, I have shown that the European vine languishes and by the third or fourth year perishes, while many of our own varieties also suffer and some of them succumb. Here we have instances, where no Phylloxera exists, of the European vines flourishing and bearing healthy fruit, as also many native varieties and hybrids, which in vineyards infested with Phylloxera, suffer or entirely succumb. One other fact comes out clearly from Mr. Berckmans' report: it is that the insect was not brought from any of the various parts of Europe from which he imported his foreign varieties. Facts like these are what we want, and not prejudiced opinions.

While it is made clear, therefore, that the Phylloxera does not occur around Augusta, the following letter from the Secretary of the Atlanta Pomological Society will show that it occurs about 160 miles westward of Augusta, in the same State; and I have little doubt but that the investigations of Mr. John T. Humphreys, who has recently been appointed State Entomologist of Georgia, will show us that it occurs more or less throughout the State:

C. V. Riley—*Dear Sir:* Your letter of Sept. 18th, and parts of 6th and 7th Annual Reports, were received, and my excuse for so long a delay in replying is absence from home and pressing business engagements. Early in October I took four vines from our vineyard that had the appearance of being unhealthy. Allen's Hybrid, Maxatawney, Walter and Delaware; all but the Walter had been planted three years—that two years.

Upon examination, with an inferior single lens glass (I could not get a good one in our city), I discovered insects, answering to the Phylloxera, on the roots of Maxatawney and Walter, in considerable numbers, but failed to find any on the others, though the roots had every appearance of being affected. It was my intention to have made further investigations, but absorbing engagements prevented.

Atlanta Nurseries, Atlanta, Ga., Dec. 8, 1875. M. COLE.

In a subsequent letter Mr. Cole writes:

I regret that it is not in my power to furnish you with roots of the Maxatawney grape vine upon which I discovered Phylloxera, detailed in my letter of 8th December. The examination was made early in October, and the subjects destroyed by burning. The examination was carefully made, and the insects clearly defined in considerable numbers, and their movements observed.

AMERICAN GRAPE VINES IN EUROPE.

The demand has steadily increased in France for American vines, and especially those varieties which most resist the Phylloxera. Messrs. Jules Leenhardt, and M. Douysset, of Montpellier, who have been large importers, state that the orders during 1875 exceeded fourteen million cuttings, and though the orders have been largest for varieties of *æstivalis*, as Cunningham, Herbemont, Jacquez, many others, including wild vines, as the *æstivalis* of our woods, and the Mustang of Texas,* have also been sent over. There has also been quite a demand from Germany for our cuttings, as well as for seed of our different varieties.

The reason for this large demand is obvious. In spite of the liberal national reward offered in France for a remedy; in spite of the well directed and persistent efforts of the Government, and of the National Academy of Science; in spite of the fact that improved methods of employing the sulpho-carbonates have been discovered, and that the use of these compounds is declared by the Phylloxera Commission of said Academy to be satisfactory—the only remedy which has been applied on a large scale is submersion, which is not everywhere practicable, and the disease has steadily continued to spread.

During my visit to South France last July, I found that in many parts of the Department of Hérault, where four years before the whole country was one vast vineyard relieved only here and there by an olive orchard, the ground was devoted either entirely or partly to other crops, and the vineyards were fast disappearing. Yet right in the midst of this desolating work of the insect, the American vines were generally flourishing, and those who had carefully grafted their own varieties on to the roots of ours were elated at the prospect.

I made numerous notes and observations in different vineyards around Montpellier; but Messrs. Planchon and Viala have since, on

* Mr. Onderdonk in a letter to Mr. Isidor Bush, expresses the belief that the *vinifera* will not graft upon the Mustang. He has tried it repeatedly, and the grafts have always died the second or third year, after making a luxuriant growth.

behalf of a special committee appointed to report on the condition of American vines there, gone over the ground so thoroughly, in their report submitted last December, that I refer the reader more particularly interested to that paper,* as also to one by my friend Isidor Bush on "American Grape Vines in Europe," read at the last meeting of our State Horticultural Society. This last was published in the *Rural World* of February 23, and March 1, last, and is a valuable and temperate presentation of the case.

There has naturally arisen a good deal of feeling and discussion as to the merits of different varieties, and this was especially noticeable between the champions of the Concord on the one hand and those of the Clinton on the other; the latter making as much capital as possible out of a statement of mine, made at a special meeting of the Central Agricultural Society of Hérault, to the effect that while the Concord is hardy and prolific and resists the Phylloxera so well that it is the popular grape with us, I have nevertheless found vines dying in exceptional instances and evidently from Phylloxera.

The demand for some varieties has very much exceeded the supply, as the Summer of 1875 was unfavorable to the growth and ripening of grape wood; and I very much fear that the French recipients will experience some disappointment in 1876 in the growth of some of their cuttings, and in the nature of others, especially those sent from the South supposed to be the Jacques.

As a large portion of the grape wood sent over to France has been sent from Missouri, our grape-growers are interested in knowing what the prospects may be for future demands. It is evident that while the demand will not cease entirely, it will never be as great as during 1875, for even on the supposition that the varieties of *æstivalis* will be grown extensively throughout the Phylloxera district for their own grapes, and that the Clinton, Concord and Taylor will be as extensively used as stocks, the French nurserymen will be able from this time forward to measurably, if not entirely, supply the demand. California grape-growers will find it advisable to adopt the same course as have the French; and a good deal of grape-wood from the East may yet find its way there.

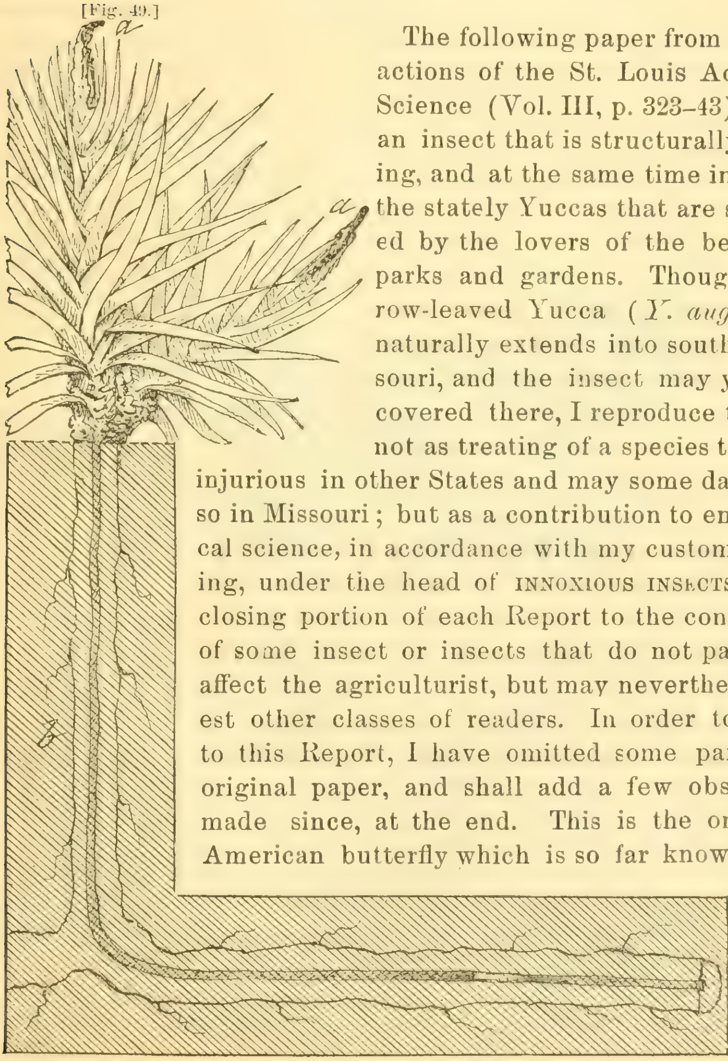
*Etat des Vignes Americaines dans le Départment de l'Hérault, pendant 1875. *Messager Agricole*, 10 Decembre, 1875.

INNOXIOUS INSECTS.

THE YUCCA BORER.—*Megathymus yuccæ* (Walker).

[Ord. LEPIDOPTERA; Fam. HESPERIDÆ.]

[Fig. 49.]



The following paper from the Transactions of the St. Louis Academy of Science (Vol. III, p. 323–43) treats of an insect that is structurally interesting, and at the same time injurious to the stately Yuccas that are so esteemed by the lovers of the beautiful in parks and gardens. Though the narrow-leaved Yucca (*Y. augustifolia*) naturally extends into southwest Missouri, and the insect may yet be discovered there, I reproduce the paper, not as treating of a species that is now injurious in other States and may some day become so in Missouri; but as a contribution to entomological science, in accordance with my custom of devoting, under the head of INNOXIOUS INSECTS, a small, closing portion of each Report to the consideration of some insect or insects that do not particularly affect the agriculturist, but may nevertheless interest other classes of readers. In order to adapt it to this Report, I have omitted some parts of the original paper, and shall add a few observations, made since, at the end. This is the only North American butterfly which is so far known to have the real boring habit in the larva state.

"He who, by a minute analysis of any animal, enables us to solve any dubious point connected therewith, does more for the elucidation of this much abused natural system than the greatest and most ingenious theorist who has yet taken the subject in hand."—WESTWOOD.

The study of aberrant forms in Nature is always interesting. They are continually confronting the naturalist. They baffle the systematist and constantly remind him of the necessarily arbitrary nature of his classificatory divisions. Few divisions seem more natural at first glance, than that of the Lepidoptera into Rhopalocera (butterflies or day-flyers) and Heterocera (moths or night-flyers). It was no sooner proposed by Boisduval than it was recognized as a most convenient arrangement, and adopted very generally. The antennæ in this Order are always conspicuous, and their clubbed or non-clubbed tips are easy of observation, and associated with other important characteristics which separate the two groups. The Sphingidæ, however, by their crepuscular habit and their antennæ thickening toward the end, though terminating abruptly in a point, bring the two groups in close relationship and diminish their value; while the Castniidæ on the one hand and the Hesperidæ on the other so intimately connect them, that it becomes almost a matter of opinion as to whether the former should be considered butterflies, or the latter moths. *Urania* and other abnormal genera* make the relationship of the two groups still more perplexing. On antennal structure alone —whether we consider the clubbed or non-clubbed tips according to Boisduval, or the rigidity, direction, and length, which Mr. Grote deems of greater importance†—two primary divisions cannot be based. If we take the spring or spine on the hind-wings, which is so characteristic of the Heterocera, we meet with the same difficulty; for a large number of moths do not possess it, while an accepted Hesperian (*Euschemon Rafflesiæ*, Macl.) from New South Wales is furnished with it. Nor is there any one set of characters which will serve as an infallible guide to distinguish moths from butterflies; and the number of moths described as butterflies, and the fact that Kirby considers the position of *Barbicornis*, *Threnodes*, *Pseudopontia*, *Rhiphcus*, *Ægiale*, and *Euschemon*, included in his "Synonymic Catalogue of Diurnal Lepidoptera" as doubtful butterflies, gives sufficient proof of the truth of the statement. Between all classificatory divisions, from variety to kingdom, the separating lines we draw get more and more broken in proportion as our knowledge of forms, past and present, increases. Every step in advance toward a true conception of the relations of animals brings the different groups closer together, until at last we perceive an almost continuous chain. Even the older naturalists had an appreciation of this fact. Linnæus's noted dictum, "*Natura saltus non facit*," implies it; and Kirby and Spence justly observe that "it appears to be the opinion of most modern physiologists that the series of affinities in nature is a concatenation or continuous series; and that though an hiatus is here and there observable, this has been caused either by the annihilation of some original group or species * * * or that the objects required to fill it up are still in existence but have not yet been discovered." Modern naturalists find in this more or less gradual blending their strongest argument in favor of community of descent, and speculation as to the origin, or outcome rather, in the near present or remote past, of existing forms, is naturally and very generally indulged, even by those who a few years back were more inclined to ridicule than accept Darwinian doctrine. Shall we then say that the old divisions must be discarded because not absolute? As well might we argue for the abolition of the four seasons because they differ with the latitude, or because they gradually blend into each other! Entomologists will always speak of moths and butterflies, howsoever arbitrary the groups may come to be looked upon, or however numerous the intermediate gradations.

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* Westwood (*Intr.* ii, 359) figures *Barbicornis Basalis*, God. as an Erycinid butterfly with tapering and ciliate antennæ.

† Proc. Amer. Assoc. Adv. Sci. xxii, B. 111.

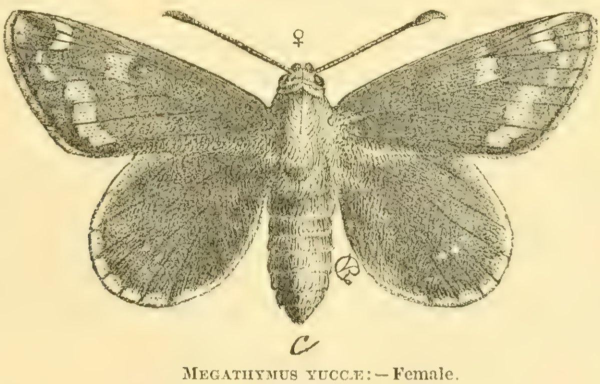
These thoughts naturally present themselves in considering so osculant a species as the Yucca Borer.

BIOLOGICAL.

The reader of these Reports is aware that the queenly Yuccas cradle and nourish a very curious and anomalous Lepidopteron—the *Pronuba yuccasella* (*cf.* Rep. V, pp. 150-60; Rep. VI, pp. 131-5). The genus is further interesting, from the entomological side, as giving us the insect under consideration.

In the home of the Yuccas, and more particularly in the home of the caulescent species, like *Y. aloifolia* and *Y. gloriosa*,* persons who have occasion to dig up the roots, or subterranean trunks, often notice that these are bored and hollowed out along the axis (Fig. 49, *b*), the burrow cylindrical, and lined at its upper end with silk, which is generally intermixed with a white glistening, soapy powder. These tunnelings are made by our Yucca Borer, which dwells therein; and their presence may generally be detected by masses of excrement observable among the leaves, and by certain chimney-like projections made by the twisting and webbing together of the more tender heart-leaves, or even of the flower-stalk, after they have been partly devoured, into a sort of funnel, from which the excrement is expelled (Fig. 49, *a*, *a*). The tunnelings weaken the trunk and induce rot, so that the plant is not unfrequently prostrated thereby; and as the insect is sufficiently common in the Gulf States to sometimes be found in every third plant over extended regions, its work renders the Yucca worthless as a hedge plant, for which it has been tried.

[Fig. 50.]



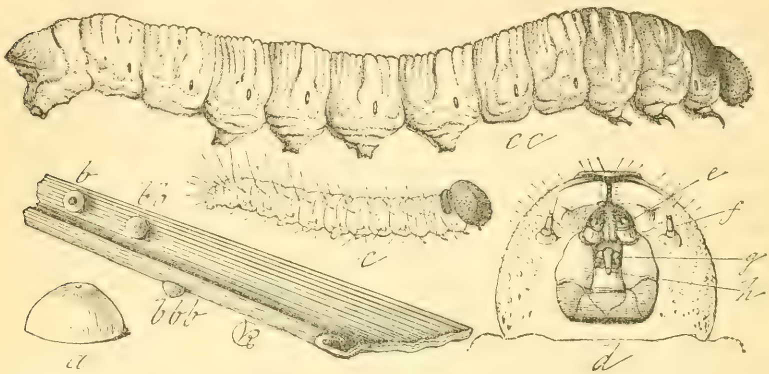
MEGATHYMUS YUCCÆ:—Female.

In the months of April and May, in South Carolina, but earlier in more southern latitudes, the parent Megathymus may be observed, where the Yuccas abound, passing, with very rapid, darting flight, from plant to plant, remaining but a few seconds at one place, during which she fastens an egg (Fig. 51, *bb*) to some portion of a leaf. She is generally seen at this work in the morning hours. The eggs, which are well-developed when she issues from the pupa, are laid singly, though several are often attached to the same leaf, generally near its tip and on the upper or under side indifferently. In the course of about ten days the young, reddish-brown larva (Fig. 51, *c*) gnaws its way out through the crown of the egg, and conceals itself in a web between some of the more tender terminal leaves. Generally, it will be found at first near the tip of a leaf

* Though I have positive proof of its working in *aloifolia*, *gloriosa* and *filamentosa*, its range does not seem to be co-extensive with this last species, as I believe the insect has not yet been reported north of latitude 36 degrees.

where the sides naturally roll up and afford a safe retreat. It then gradually works to the base, feeding the while and rolling and shriveling the blade as it descends. Other blades are often joined, and, in fact, the insect lives among the blades till it is about

[Fig. 51.]



MEGATHYMUS YUCCÆ:—*a*, egg, side view, enlarged; *b*, egg from which the larva has hatched; *bb*, *bbb*, unhatched eggs, natural size; *c*, newly-hatched larva, enlarged; *cc*, full-grown larva, natural size; *d*, underside of head of same, enlarged to show the trophi.

one-fourth grown, and seldom enters the trunk before that time. How soon, in the larval development the white powdery secretion already spoken of appears, or how many larval molts occur, has not been ascertained; but the more mature larva is always more or less covered with this powdery matter, which doubtless serves as a protection from the mucilaginous liquid which the tissues of the Yuccas contain and freely exude upon interference or maceration. Pupation does not take place till the subsequent late Winter or Spring; there being, from all that I can ascertain, but one brood each year. The burrow often extends two or more feet below ground, and during the coldest weather the larva probably remains in a partially dormant state at the bottom. Occasionally two larvæ inhabit the same trunk, in which case their tunnelings are kept separate, side by side. The pupa state (Fig. 52) is generally assumed just below the chimney-like funnel at the top of the burrow, and no other preparation is made for it than partial closing, near head and tail, to insure suspension. This funnel is, in reality, built and extended by the larva, and what little matter besides silk goes to make its exterior has been added and worked in from the outside. In the several larvæ that I have had feeding in breeding-cages, this habit of building up and making tubes, for which remnants of leaves and other extraneous substances are pressed into use, struck me as quite characteristic; and in one instance I have had such a tube extended over nine inches from the tunneled trunk, the moss on which the section of Yucca rested being used in its construction.

[Fig. 52.]

MEGATHYMUS YUCCÆ:—Pupa.

In the issuing of the imago the pupa skin is rent on the middle of the notum and across the eyes, and the casings of the legs are never, and those of the antennæ seldom, severed from their solderings in the exuvium.

The imago rests (Fig. 53) with its antennæ, slightly diverging and generally directed forwards; with the wings elevated, closely appressed, and with the costa of primaries at an angle of about 45° from the body. Regarding the flight, which is diurnal, Dr. J. H. Mellichamp, of Bluffton, S. C., was impressed with the extremely rapid and darting motions of the insect as it passes from plant to plant; and Mr. E. A. Schwarz, of Detroit, who has had very excellent opportunity of observing the species in Volusia county, Florida, informs me that, when startled, Megathymus flies directly upward 20 or 30 feet, then horizontally for a long stretch—sometimes out of sight—and descends as directly as it rose. It frequents open places, is very shy, and generally settles near the ground.

[Fig. 53.]

MEGATHYMUS YUCCÆ:—Walking.

BIBLIOGRAPHICAL.

The first notice of this insect that we have any record of is that by Boisduval and LeConte, who figure it under the name of *Eudamus? yuccæ* on Plate 70 of their *Iconographie*.* Though there is no text accompanying the plate, it is evident, from the generic reference, that the insect is considered Hesperian, and no one could hesitate to so consider it if guided by the figures. In those of the imago the head is unnaturally broad, the body too slender, and the antennæ with the club too slender and too much hooked. The wings, in repose, are thrown forward as in *Thecla*; the antennæ erect, and the legs too slender. The larva has the large and nutant head, narrow thoracic joints, and green, yellow and white longitudinal stripes so characteristic of Hesperid larvæ. The pupa has much the form and color of *Epargyreus Tityrus* (Fabr.) In short, these figures, in many respects, and those of the larva and pupa more particularly, are so unlike the insect considered in the present paper, that the question might justly be raised as to whether I am dealing with the *Yuccæ* of Boisduval and LeConte, if the figures in the work in question were known to be generally trustworthy. But I have already shown† how inaccurate and unreliable some of the said figures are; while the food-plant, as indicated by the specific name, and the size, markings and color of the perfect insects in the plate, leave no doubt as to the identity of *Yuccæ* B. & L., and the species here considered. Too much imagination entered into the composition of that plate, and the probability is that after LeConte's figures were received in Europe by Boisduval, the latter, by mistake, coupled with *Yuccæ* the larva and pupa of some other large Southern Hesperian.

The next reference to this insect is by Walker,‡ in 1856, who is the first to briefly describe it as *Castnia yuccæ*. In 1871, Kirby referred it doubtingly to *Ægiale*, Feld. in Hesperidæ.§ In 1872, Scudder made it the type of a new genus (*Megathymus*) in Hesperidæ‖, without further diagnosis than the incorrect figures in the *Inconographie* alluded to. This reference is followed by Wm. H. Edwards in the Synopsis accompanying the first volume of his work on N. A. Butterflies (1872). Scudder subse-

* *Hist. Gén. et Icon. des Lépid. de l'Am. Sept*, 1833.

† Sixth Rep., p. 136.

‡ List of the specimens of Lep. Ins. in the Coll. of the British Museum, Part VII., p. 1583, No. 43.

§ Synonymic Cat. Diurnal Lep., p. 608. W. F. Kirby: London, 1871.

‖ Systematic revision of some of the Am. Butterflies, etc., p. 62. S. H. Scudder: Salem, 1872.

quently states that "it is not a butterfly,"* and Mr. A. R. Grote, after an examination of specimens collected in Florida, regards it "as belonging to the Castnians, where it is placed by Walker."†

It will thus be seen that this insect has sorely perplexed systematists, having been bandied from the butterflies to the moths; and that the balance of opinion withdraws it from the butterflies and places it with the Castnians—a family which, in some respects, combines the characters of the two great Lepidopterous divisions, but is regarded, and justly, as having most affinities with the moths.

I shall endeavor to show that this opinion is not well-founded; that *Megathymus* is a genuine butterfly, and that its greatest affinities are with the Hesperians. Together with one or two other species it forms a small, abberrant tribe; but, in order to more fully discuss its affinities, it is necessary to give an exposition of its characters, as no detailed descriptions have yet been published.

DESCRIPTIVE.

Egg—Subconical, the top flattened or depressed, and with a slight central dimple; the attached base concave; smooth but not polished. Color, pale green when laid, inclining to buff-yellow or brown before hatching. Diameter at base 2.5 mm.; height 1.8 mm.; the traverse diameter often varying slightly in two cross directions. Fourteen examined that were naturally deposited and many more in the ♀ abdomen.

Larva—Newly-hatched larva (Fig. 51, *c*); Length 6 mm. Color dark brick-red with pitchy-black head and cervical shield; the abdominal joints showing two principal transverse folds. Six longitudinal rows (2 dorsal on anterior fold, 2 subdorsal, and 2 stigmatal on posterior fold) of black stiff hairs, arising either directly from the skin or from very small tubercles, longest posteriorly where they often exceed in length the diameter of the joint bearing them; some less conspicuous stigmatal and subventral hairs. Head larger than first thoracic joint, rounded, but rather flat in front; cervical shield narrow and in one piece; both minutely punctate. No anal plate. Full-grown Larva (Fig. 51, *cc*—Average length 2.60 inches; diameter 0.40 inch. Color edematous white. Surface faintly aciculate, and sparsely armed, dorsally, with minute, evenly distributed, short, rufus bristles, springing from the general surface, and not very noticeable with the naked eye; covered more or less copiously with a white, glistening, powdery secretion.‡ Cylindrical, the abdominal joints with 8 annulets, the first 3 occupying anterior half, the 3rd most prominent and widening laterally, and the other 5 on the hind half of the joint—all best defined dorsally. The thoracic joints somewhat larger than the rest, more deeply and irregularly wrinkled; the substigmatal region with longitudinal folds. *Head* black, perpendicular, and asperous or deeply shagreened; epistoma and labrum brown, small, and usually with a transverse median ridge, the ⅄-shaped mark white, forking before the suture, and the forks having the shape of U: mandibles stout, subtriangular, non-dentate: antennæ (Fig 51, *f*) 2 jointed, exclusive of bulbus, the terminal joint twice as long as the basal, sometimes showing a faint constriction, and with an apical nipple and long seta: maxillæ and labium and mentum forming a subquadrate piece, bulging out prominently from beneath, the parts seemingly soldered together and separated only by deep sutures, the maxillary palpi (Fig. 51, *e*) consisting of two broad joints, the second surmounted by two stout nipples squarely docked at tip, the inner one stoutest and both armed with bristles (the parts not clearly shown in figure): the labium small, trapezoidal, highly polished, with the spinneret (*h*) twice as long as palpi (*g*) which are small, recurved and 2-jointed, exclusive of bulbus: a few stout bristles on labrum, on palpigerous piece of maxilla, on mentum, base of mandibles and around the ocelli, which are not easily distinguished from the more globular of the shagreenations. Cervical shield more glabrous than head, and scarcely darker than the body except around hind border. *Thoracic legs* very short but stout, with the horny parts deep brown, and sparsely armed with bristles. Prolegs well developed, the hooks in double row and forming a distinct purple-brown, transversely oval annulus, but slightly broken at the narrow ends. *Anal shield* rounded behind, coreaceous rather than corneous, and with a slight increase of bristly hairs, especially around border. *Stigmata* large, with a purple-brown, oval annulus.

* Historical Sketch of Generic Names proposed for Butterflies, p. 213. Salem, 1875.

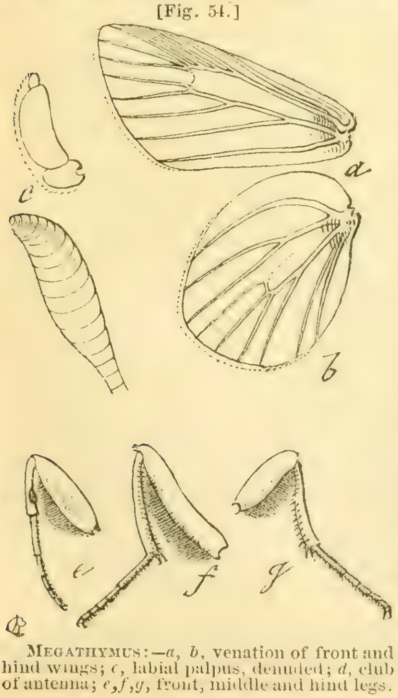
† *Canadian Entomologist*, September, 1875, p. 173.

‡ This secretion is of a waxy nature, analogous if not identical with that secreted by so many Homopterous and some Hymenopterous larvæ. It is soapy to the touch, and dissolves readily in alcohol, leaving however a distinct scum on the surface.

PUPA—Average length 1.50 inches. Cylindrical; broadest at shoulders, the abdomen large, recurving ventrally toward anus, and terminating in a broad, flattened, posteriorly rounded, transverse, slightly decurving flap, the borders thickened basally and extending ventrally so as to surround the bilobed anus. Eyes prominent, with a transverse carina: wing-sheaths reaching hind part of 4th abdominal joint, ventrally; hind tarsi to about the hind third of these, and the club of antennæ—which forms a prominent bulge but tapers to a point—nearly as far. Surface but slightly polished and faintly corrugate; a few extremely minute bristle-like spines distributed over the abdominal joints, dorsally, and the two or three terminal joints with stiff rufous hairs, increasing posteriorly and thickest on the flap. Chitinous covering delicate, and all the members clearly defined. Prothoracic spiracle showing as an opaque, dull fulvous elliptic-ovoid wart. Color brown-black anteriorly, paler on the abdomen, and more or less densely covered with a white powdery secretion like that which characterizes the full-grown larva.

IMAGO.—Generic Characters—Head small, the width, including eyes, not much more than half that of the mesothorax; the antennal bulbus large, and the inter-antennal space not wider than one of the sockets; covered with rather evenly shorn, dense hairs, and flattened scales not overhanging the eyes. Eyes small and smooth. No ocelli. Labial palpi (Fig. 54, *c*) stout and short, not reaching to top of eyes, 3 jointed, the basal joint broad but short, the middle joint 4 times as long, the terminal joint tuberculous and one-sixth as long as the preceding: clothed in short and thick hair-like scales. Tongue filiform, rather more than one-half the antennal length. Antennæ rigid, cylindrical, terminating in an elongate knob (Fig. 54, *d*) which is slightly flattened and slightly tapering and recurved at tip, but without apical spine or tuft: having rather more (♂) or rather less (♀) than half the costal length of primaries. *Thorax* very robust, recalling that of *Xyleutes;* clothed with close-lying hair which becomes longer and looser behind; the patagia rather broad, forming two crescent-shaped, slightly raised layers; the tegulæ closely appressed. Legs (Fig. 54, *e*, *f*, *g*, front, middle and hind) with brushy hairs beneath the femora; the tarsi all studded beneath with minute reddish spines, the hind and middle tibiæ still more strongly spined, and each with a pair of more prominent spine-like, apical spurs of equal size, and hardly longer than the other spines in ♂ and not longer than the diameter of tibiæ in ♀: the front tibiæ unarmed, the nodule on the inner apical third ovoid and dark: tarsal claws with a very small pulvillus between them: front femora 5.5 mm. long; tibiæ rather more than half as long; tarsi as long as femora: middle femora 7.4 mm. long; tibiæ and tarsi but slightly shorter: hind femora same length as front ones; tibiæ one-fifth longer.

[Fig. 54.]



MEGATHYMUS:—*a*, *b*, venation of front and hind wings; *c*, labial palpus, denuded; *d*, club of antenna; *e*,*f*,*g*, front, middle and hind legs.

Wings, with the scales small but mostly long, narrow and dense, with long hair at base superiorly and with the general shape and venation (Fig. 54, *a*, *b*) of *Hesperia*, the primaries with the apical angle more acute, but less so than in *Thymele;* anal angle not produced but rounded: secondaries narrow and more rounded than in any other Hesperid genus known to me: veins quite stout. *Abdomen* ♀, very stout and heavy, thickening behind, blunt at tip, and truncate below; ♂ more slender and gradually tapering. Specific Characters.—Average expanse 2.50 inches; length of body 1.12 inches. General color, above, deep umber-brown, the body more grayish, especially the tegulæ; the longer hairs of the mesothorax and base of abdomen inclining to ferruginous: whitish in front and around the neck and back of the eyes. Primaries with a notched ferruginous band on the outer fourth bounded by veins 1 and 4; a narrower mark running from the posterior margin of this between 4 and 6; a paler mark in a line with the first band between 6 and 9, and a ferruginous mark again just within the discal area—the veins traversing the spots showing distinctly black: an apical shade, a costal streak between veins 8 and 9, and alternate marks on the fringes, are pale yellowish; while the basal hairs are ferruginous. Secondaries with a ferruginous border and straw-yellow fringes. In the ♂ the antennal stem is paler, the spots on primaries smaller and paler, and the border on secondaries wider; while in the ♀ the secondaries have from two to four ferruginous spots just outside of the disc and between the inferior veins.* Beneath, the whole coloration is brighter, the spots between veins 6 and 9 being pure white, the others saffron-yellow, and the posterior portions of all the wings, and a broad costal streak on secondaries, pearly-gray; a spot of the same color is observable on the outer third of secondaries below vein 2, a more distinct and triangular mark on the inner third just below the costal vein; while the orange superior spots in ♀ show dark brown. The antennæ are white with the exception of the club; the palpi and front trochanters whitish-gray, deepening posteriorly. The legs are brown with the tarsi but faintly tinged with gray.

The ten specimens that have come under my observation show considerable variation, aside from that which is sexual, in the depth of color and size of the spots, as well as in the distance between them and the hind border of the wing; but none of them have the spot on primaries, indicated in one of Boisduval's figures, just within the middle of the wing and below vein 2.

AFFINITIES.

Let us now compare the foregoing detailed characters with the Castnians on the one hand and the Hesperians on the other.

Scudder, who has certainly given more attention than perhaps any other author to the Hesperians, divides them into two groups, which he considers of tribal value.† The first to which he applies Latreille's name *Hesperides* is characterized chiefly by the primaries in the ♂ having a costal fold (often inconspicuous, however;) by the posterior extremity of the alimentary canal being protected beneath by a corneous sheath, which extends beyond the centrum or body of the upper pair of abdominal appendages, sometimes nearly to the extremity of the appendages; by the club of antennæ being elongate, roundly bent, or with a sinuous lateral curve; by the prevailing color being dark brown with white or translucent angular spots; by the stout body and swift flight; by the eggs being distinctly ribbed vertically; and by the larvæ generally feeding on leguminous plants and living in horizontal nests made with the leaves. The second tribe, to which he gives Hübner's name *Astyci*,‡ the front wings of ♂ have no costal fold; the extremity of the alimentary canal is not protected by any extruded sheath; "the prevailing tints of the wings are tawny and black, marked also but often feebly with pale, sometimes vitreous, spots;" the antennæ have a stout club, which either tapers rapidly or is devoid of a crook; the hind wings are usually horizontal in rest; the eggs are smooth, usually broader than high; and the larvæ "feed on Gramineæ, and generally construct vertical nests among the blades."

The eggs of the Castnians are, so far as I am aware, unknown and undescribed. In both butterflies and moths they present an infinite variety in form, in sculpture, and in the manner in which they are laid. As a rule, however, those of the larger moths are either ovoid, spherical or flattened, and rarely subconical or sculptured; while those of butterflies are more often conical, and present greater variety in form and sculpture. The eggs of Hesperians are subconical, and those of the Astyci, as we have just seen, in being smooth and broader than high, agree exactly with those of *Yuccæ*.

The larvæ of the Castnians are, according to Boisduval§, endophytous, boring the stems and roots of Orchids and other plants, like the Sesians and Hepialians, and like *Yuccæ*. But they are ornamented with the ordinary horny piliferous spots or warts which characterize Heterocerous larvæ, and have a horny anal plate. Butterfly larvæ, on the contrary, rarely possess these warts, but frequently have the body uniformly beset

* The secondary sexual characters are confounded by Boisduval, as quoted by Morris (Synopsis of Lep. of N. A., p. 113,) though, as there is no text in the *Iconographie;* the error doubtless originated with Morris in making descriptions from the figures.

† Bulletin Buffalo Soc. Nat. Sci., p. 195.

‡ I think such diversity of ending in terms used for divisions of the same value should be avoided.

§ Suites à Buffon; *Sphingides, Sesiides, Castniides;* Paris, 1874.

superiorly with close-shorn bristles as in *Yuccæ*, such bristles generally springing from minute papillæ. The newly hatched larvæ of the two divisions approach each other more nearly in general appearance, as all animals do, the farther we go back to the commencement of individual life; but though the newly hatched larva of *Yuccæ* bears a general resemblance to the same stage in many endophytous Heterocerous larvæ (e.g. *Xyleutes*, *Cossus*,) yet in the stiff hairs springing from the general surface, or from very minute points, instead of from distinct tubercles, it agrees with the Rhopalocera. The legs, both false and true, together with their armature and the trophi, are so extremely variable in both divisions that comparisons can hardly be instituted. The endophytous habit, though very exceptional, is found in butterflies (e.g. *Thecla Isocrates*, Fabr.: see Westwood's Intr., ii., p. 369.) None of the Heterocerous borers, so far as my experience goes, line their burrows continuously with a matting of silk; but use the silk very sparingly, or not at all, till about ready to pupate. The larva of *Yuccæ*, for the most part, lives in a tube of silk, which it builds and extends often several inches beyond the trunk or stem in which it burrows, and from which it often, especially when young, issues to feed. In this, again, it approaches the Hesperians, which are partial concealers, and live, when not feeding, within silken cases or tubes constructed among the leaves of their food-plants.

The pupæ of the Castnians, like those of all Heterocerous borers known to me, are, according to authors, armed with rings of minute spines on the hind borders of the abdominal joints—the spines serving a very useful purpose in assisting the pupa out of its cocoon. Heterocerous borers also pupate in a more or less perfect cocoon, made either within or without the burrow; and, in the issuing of the imago, the mesothoracic covering generally collapses, the leg-cases become unsoldered, and those of the antennæ are always separated and often curled back over the head in the exuvium. The Hesperians pupate within the silken cavity occupied as larva, or else in a separate slight cocoon: the pupa is generally attached to a silken tuft by the hooks of the cremaster, and sometimes by a silken girth around the middle of the body besides; it is not unfrequently covered with a slight powdery bloom, and is characterized by the prominence of the prothoracic spiracle*: the exuvium more nearly retains its form, the leg-cases remaining soldered, and even those of the antennæ being rarely separated. In not having a well-formed cocoon, in being covered with bloom, in the characters of the exuvium, in the conspicuity of the prothoracic spiracle, but more particularly in the want of minute spines on the borders of the abdominal joints, *Yuccæ* is again Hesperian and not Castnian. Indeed, except in the broader anal flap, densely surrounded with stiff bristles, in place of an apical bunch of hooks, in the smaller head and larger body, it resembles *Nisoniades* in general form, color, and texture.

The typical Castnians, in the perfect state, have the wings large with loose and *very large* scales, and the hind-wings *invariably* armed, at costal base, with the *long stout spine*, or spring, which serves to lock the wings in flight by hooking in a sort of socket beneath the primaries, and which is so characteristic of the Heterocera. The venation resembles more nearly that of the Hepialians, and is totally unlike that of the Hesperians. The veins are slender; in the primaries 1*a* and 5 are as stout as the rest; the discal cell is short, connected transversely with 3 and with an areolet above: in the secondaries the cell is nearly obsolete, and the independent or vein 5 of secondaries is as stout as the others. (Comp. Fig. 54 *a*. *b*. with Fig. 55) The antennæ, though thick-

* In *Nisoniades Juvenalis* (Fabr.) this spiracle takes the form of a prominent sooty-black horn or tubercle.

[Fig. 55.]

Venation of Castnia Phalaris (Fabr.)

ened at tip, are generally long and more or less supple, and there are two distinct ocelli between the eyes, behind the antennæ. The Castnians vary much in general appearance, but whether we deal with the Brazilian *Castnia Linus* (Cram.) with its narrow, elongate, rounded, clear-spotted wings, and its remarkably elongate and swollen basal joint of the middle tarsi; or with *C. Licus* (Cram.) which has broad, angular wings; or with the genera *Ceretes*, *Orthia*, *Gazera*, and *Synemon*—we find the characters above mentioned constant: they are typical of the Family and are Heterocerous characters. *Yuccæ*, on the contrary, has none of these characters, but in the smaller wings, in their venation, in the closeness of the small and narrow scales and hairiness at base, in having no ocelli, and in the unarmed secondaries, entirely agrees with the Hesperians. I attach much less importance to the antennæ, size of head and body or even the spurs of tibiæ; because they are all more variable. Thus, while most of the Castnians have the antennal club tipped with a spine or a bunch of bristles, others (e. g. *Castnia Orestes*, Walker, from Surinam,) have it of the same shape as in *Yuccæ*, and unarmed or even more short and blunt (*Synemon Theresa*, Doubl.) Again, in most Hesperians the club tapers, or is curved at tip; but there are all degrees of variation, from the extremely curved club of *Epargyreus Tityrus* (Fabr.) to the straight and blunt club of *Oarisma Poweshiek* (Parker). The small head and subobsolete spurs in *Yuccæ* are abnormal compared with either family; for most of the Castnians have the spurs much as in *Hesperia*, and the head almost as broad as the thorax. In the stiffer, relatively shorter antennæ, with large club; in the spines which stud the tibiæ,* as well as in the stoutness of the thorax and abdomen, *Yuccæ* is again Hesperian rather than Castnian. The Castnians, like the Uranians, and many other exceptional moths, resemble the butterflies in being day-flyers; but the position of the wings in repose, which is a more important character, is said by all observers to be similar to that of *Catocala*, *Drasteria*, and other Heterocera, viz.: deflexed or incumbent. *Yuccæ*, both in manner of repose, in color, and in pattern, is a staunch Hesperian.

In short, a careful consideration of the characters of our Yucca Borer shows that in all the more important characters it is essentially Hesperian; and that in most of those characters by which it differs from the more typical species of that family—as in the small spurs, in having only the apical ones on the hind tibiæ, in the tibial spines, and difference in size of legs—it is more Rhopalocerous than Heterocerous. The same holds true when we consider the adolescent states. In the small head of both larva and imago, and in the very large abdomen, it is abnormal; but these characters are traceable to the abnormal larval habit, and are very unimportant compared to the pterogostic and other characters cited. I have long since concluded that general larval form and appearance is so dependent on habit and so variable according to habit, that it is less valuable than more minute structural characters, and that for purposes of classification it has even less value than egg-structure, and infinitely less than imaginal characters. All endophytous Lepidopterous larvæ, of whatever family, have certain general resemblances that are a consequence of similarity of habit; and I give it as my emphatic opinion that *Yuccæ* is a large bodied Hesperian, which, though approaching the

*In the Castnians that I have been able to examine none of the tibiæ have spines, while those on the tarsi are very minute; the middle tibiæ have a pair of unequal, prominent sub-apical spurs, and the hind tibiæ have two similarly unequal pairs, the anterior pair from about the terminal fifth.

Castnians through *Synemon*, has no real relation with them. In certain marked characters it departs from the Hesperians as at present understood, and the only question which a careful study of the species gives rise to in my mind is—not whether it should be considered a Castnian, but whether it offers characters that necessarily separate it from the Hesperians. Families should, I think, be made as comprehensive as possible and not unduly multiplied; and in considering aberrant forms, the objects of classification are best subserved by retaining them in whatever division can claim the balance of characters. It is better to widen than to restrict in the higher groups. LeConte does better service in bringing Platypsylla among the Coleoptera than does Westwood in creating a new Order—Achreioptera—for it. Phylloxera, in Homoptera, is much more wisely retained in the Aphididæ than made the type of a new Family. Let *Yuccæ*, therefore, be retained in Hesperidæ. By its aberrant characters it may constitute the type of a third tribe, for which I would propose the name *Castnioides*. This Tribe consists at present, in addition to *Megathymus yuccæ*, of two other good species,* the one from Mexico, the other from Costa Rica. It is very probable that the number will be greatly increased as we become more familiar with the Lepidopterous fauna of Mexico and Central America, where the Yuccas and Agaves abound; for I have little doubt that the last-named plants will also be found to nourish other species of the Tribe.

ENEMIES.

I have reared from the Yucca Borer eleven Tachina flies, all belonging to the species which I have designated *anonyma*, and which infests the larvæ of a number of other Lepidoptera.† The fact that *Yuccæ* is attacked by such a parasite is further proof that it is more or less an external feeder, since it is hardly probable that the parent Tachina would enter the burrow, and I know of no genuine endophytes that are similarly attacked.

CONCLUSION.

Whether we have in our Yucca Borer a remnant of more ancient and synthetic types from which the Castnians on the one hand and the Hesperians on the other are derived, or whether we have in it a more recent variation from the more typical Hesperians, are questions which, with present knowledge, permit only of a speculative answer. The former hypothesis is, however, the more plausible. The Castnians, while occurring in Mexico, find their greatest development in Central America and Brazil. The few Castnioides known, inhabit the southern part of North America. During the tertiary period, when the ocean reached over the whole Mexican plateau northward, the fauna of North and South America was much more similar than at the present time. It is not difficult to conceive how a Lepidopterous family that was then common to both divisions of the continent, may since that time have deviated in the two directions indicated, and yet have left some less modified forms in the intermediate country. We are assisted in this conception if we view, with some botanists, the Yuccas as remnants of an ancient flora.

We may learn from the history of this butterfly, as from that of the Hackberry butterflies,‡ how unsafe it is to describe, and particularly to create genera, from mere drawings. Megathymus, as founded on Boisduval's figures, is very much of a myth. It

Ægiale Kollari Felder and *Æ. indecisa* Butler and Druce.

†4th Rep., p. 129.

‡6th Rep., p. 150.

is so with all genera erected by the mere coining of a name without recognizable definition; and while a Hübner, in making a number of divisions on superficial grounds, may accidentally hit upon relationships which subsequent research proves correct, he certainly does not greatly benefit science by his work. Again, we may learn the necessity for the adoption by entomologists of some rules for guidance in matters that do not come within the scope of present accepted rules. Can names connected solely with published figures be accepted? Shall we write *Yuccæ* Boisduval or *Yuccæ* Walker? Such questions become the more important when two different names are employed. A figure, however good, cannot be considered a definition; and, whilst most entomologists would consider that the species in question had not virtually been named until described by Walker, others take a different view, and perhaps with reason, since a good figure, so far as recognition of the thing intended is concerned, is infinitely more definite than the majority of the earlier descriptions of species in entomology.

In conclusion, I take pleasure in expressing my obligations to Mr. W. F. Kirby, of Dublin, Mr. John A. Ryder, of Philadelphia, and Mr. Herman Strecker, of Reading, Pa., for kind assistance in my studies of this insect; and more particularly to my esteemed correspondent Dr. J. H. Mellichamp, of Bluffton, S. C., for his efforts in furnishing material, and to my friend Mr. S. H. Scudder of Cambridge, Mass., for valuable aid, always freely given.

Since the above article was written I have been able to make some further observations on the manner of pupation, on the flight of the butterfly and on the early larval habit.

The exposed portion of the blackened, chimney-like funnel, made by the larva, has a length of from four to six inches; but the funnel virtually extends from one to three inches below the still green and growing leaves before it reaches the more solid portion of the trunk where the true burrow may be said to commence. Throughout this entire length the funnel is elastic with a tendency to contraction. It is within the hidden base of this elastic funnel, or just above the burrow proper, that the pupa state is generally, if not always, assumed. A more careful study of Yucca tops in which the pupa was naturally formed—i. e. in plants not cut till after pupation—shows me, also, that the partial closing of the burrow near head and tail is due solely to the elasticity of the funnel. No additional silk is used, and nothing that can well be called a cocoon is constructed. Just above the natural contraction that occurs at the junction of the more elastic with the more firm and solid portion of the burrow, the pupa rests—the cast-off larval skin generally helping to close up the lower passage. Here the pupa has perfect freedom of motion, and readily twirls the lower part of the body when disturbed. The natural recurvature of the abdomen, as shown in the figure, presses the bristled, dorsal and terminal portion of the body on the one side, and the ventral, middle portion on the other, against its elastic confines, and holds it securely. A few muscular movements, aided by the leverage and hold which the aforementioned bristles insure, bring the pupa, when the imago is about to issue, toward the top of the funnel, which readily opens under the pressure, since it is closed only by contraction. In the issuing of the imago the pupa remains within the tube.

Having let several of the butterflies loose in a spacious chamber in order to watch their movements, I can confirm what has been said of the rapidity and strength of their flight. I would further add, that, in resting or walking, as in all their actions, they have the characteristics of the larger bodied skippers. When the wings are not used in flight, the inferior portion of the secondaries is folded along vein 1 and tucked in under the submedian, as is, I believe, the case with all Hesperians. At rest, the outer portions of primaries are brought closely together. The favorite position of the insect when at rest is vertical, or even hanging from beneath an oblique object. In walking, the wings open more or less, but the hind ones are not held horizontal. In walking on a flat surface, the fore body is strongly raised on the legs, while the end of the abdomen, especially in the female, generally touches the ground, so that the costæ of primaries are nearly on a plane with the surface. The antennæ are most often on a plane with the body, and strongly diverging.

About the middle of April I had a number of larvæ hatch, and have been able to watch these on two plants of *Y. aloifolia* in-doors and on one out-doors. The habit of living at first within a cylinder made by one of the rolled leaves, webbed across with silk, is very marked, and even where the larva at first works at the base of a leaf it will web the leaf up and feed along up to its tip before entering into the more solid portions of the plant. In extruding the excrement the larva backs up to the end of the retreat which is kept only partially closed. One specimen I have kept from the time of hatching in a tin box, occasionally supplying it with fresh leaves. It forms a retreat of these and appears to thrive as well as the others. It went through the first molt the 10th day after hatching, and through the second molt 11 days subsequently, and, judging from the size of the head in this third stage and of the insect, there will be two more molts or four in all. Toward the end of the third stage the larva measures 1.20 inches.

In the *second stage* the head is deep gamboge-yellow, with dark jaws—not polished but faintly chagreened: the cervical shield is narrow, entire and polished black; and an anal plate is obvious, also polished, dark brown, with the hind borders thickened and black. The body is olivaceous-brown. the stiff, black hairs of the first stage are very much shortened and pale, and the whole surface has a faintly pubescent appearance, caused by numerous minute points, each giving rise to a short soft hair. The wrinkles of the mature larva are already well defined. In the *third stage* the head is chesnut-brown, and the stiff, piliferous hairs are scarcely longer than the other minute ones on the general surface. The larva has now all the characteristics of the last stage, except in lacking the white powder, and in being of a pale olive-brown color. The cervical and anal shields are still highly polished and black, and the skin, instead of looking faintly pubescent, as in the previous stage, is translucent and glossy.

Where several larvæ hatch out on the same plant (which not unfrequently happens,) there is a struggle as to which shall usurp the privilege of entering the stem, and the first one to do so generally keeps the others out on the leaves, so that in the end they doubtless perish. The parent is by no means particular as to where she fastens her eggs, for Dr. Mellichamp has sent me dry leaves of *Quercus falcata* that had accumulated around his Yuccas, and that have eggs fastened to them.

Regarding the boring habit in butterflies I learn from Prof. P. C. Zeller, of Stettin, Prussia, that there is also a Hesperian (*Erynnis alceæ*, Esp.; *malvarum*, Hoffm.) which Kirby gives as common to Europe, Asia and Africa, whose larva bores in Autumn into the stems of its food-plant, (*Malva sylvestris*) in which it hibernates, and in which it goes through its transformations the following Spring.

THE ARMY WORM.

ADDITIONAL NOTES ON THE MODE, PLACE AND TIME OF OVIPOSITION.

COMPLETION OF THE INSECT'S NATURAL HISTORY.

It gives me pleasure to announce ere closing this Report that, since the article on the Army Worm was written and printed, I have been able to settle by direct observation the questions therein discussed as to the time, place and manner of oviposition. By persistently searching during the early part of April for the moth, I was rewarded by taking a number of specimens at sugar and others at large and while engaged in the act of laying. All the latter specimens have been found in an undisturbed blue grass plot behind the St. Louis fair grounds. As they are not easily disturbed while in the act of oviposition, it is only occasionally that one will fly up from the disturbance of walking over the grass. They fly low and soon bury themselves in the grass. By carefully watching I have ascertained that the favorite place to which the female consigns her eggs in such grass is along the inner base of the terminal blades where they are yet doubled. The compressed, horny ovipositor, which plays with great ease and tentative motion on the two telescopic subjoints of the abdomen, as described on p. 32, is thrust in between the folded sides of the blade, and the eggs are glued along the groove in rows of from five to twenty, and covered with a white, glistening adhesive fluid, which not only fastens them to each other, but draws the two sides of the grass blade close around them, so that nothing but a narrow glistening streak is visible. I think also, that the two edges of the grass blade are sometimes clasped by the opening hind border of the ovipositor, so as to give the insect a firmer hold, and fold the leaf more closely on the eggs. Finding it difficult to make satisfactory observations in the field, I transferred living moths to glass cages which were furnished with blue grass sward. Here again most of the eggs were laid in the manner described, and on the green and dry blades indifferently: some were, however, thrust in between the sheath and stalk, as I had anticipated they might be, while others were thrust into the crevices on the sides of the sward, which had been cut with a knife.

The female having once commenced to lay, is extremely active and busy, especially during warm nights, and I should judge that but two or three days are required to empty the ovaries, which have a uniform development. A string of 15 or 20 eggs is placed in position in two or three minutes, and by the end of ten more I have known the moth to choose another leaf and supply it with another string. Many must be laid very soon after vegetation starts, as some moths taken in the middle of April had already exhausted their supply; yet the bulk of them are not laid till toward the end of April. Very few of the moths and only those captured at sugar looked at all fresh, while all those having the eggs fully formed showed unmistakable signs of having hibernated; in fact most of those found laying had the wings so tattered and rubbed that they were scarcely recognizable. The moth perishes within a day after having exhausted her supply of eggs. The egg is glistening white when first laid, and only becomes tarnished or faintly dull yellowish toward maturity. Just before the hatching of the larva which, in a uniform temperature of 75° F. takes place from the 8th to the 10th day after deposition, the brown head of the embryon shows distinctly through the shell. The newly hatched larva is dull translucent white in color, with a uniformly brown head, and the two front pair of prolegs are so atrophied as to necessitate the looping of the body in traveling. The development of my larvæ, reared in a uniform room temperature of about 80°, has been remarkably rapid. They underwent five molts and but three days intervened on an average between each. Yet under the same conditions, the issue from the same string of eggs will manifest considerable variation, and some of them have passed through the last before others have reached the fourth.

It is thus evident that the conclusions arrived at in the body of this Report on such points as had not been settled by direct observation, are essentially correct so far as the above recorded facts bear on them. The only part needing correction is on pp. 35–36, where the statement that the moth will not oviposit in confinement, should be qualified by adding, "when reared indoors from the larva," which was indeed implied. When the ovaries are fully developed the moth will oviposit under any circumstances, and will thrust her eggs into any recess whatever, or even scatter them on the ground. I doubt very much whether she can well deposit her eggs in the favorite position, except where the grass is quite thick, or where there is a matting of old grass, as she could not well support herself where the blades are single and sparse; and from this view we get another reason why burning all the old and prostrate blades and stalks prevents the origin of the worms, in such burned places. I will conclude these supplementary notes with descriptions of the egg as laid, and of the different larval stages.

Egg—When first laid, spherical, 0.02 in diameter, smooth, opaque white; covered with a glistening adhesive fluid; shell delicate, becoming faintly irridescent and more sordid before hatching.

Immature Larva—When newly hatched 1.7 mm. long: dull translucent white in color, with very minute piliferous points giving rise to pale hairs. Head large and uniformly brown-black. Two front pair of prolegs atrophied so as to necessitate looping in motion. Drops by means of a web. In the *second stage* it is quite active, still loops, and spins a web and drops at least disturbance. Head copal yellow, with six black ocelli (the two inferior somewhat separated from the others) the brown jaws, and brown marks on the legs conspicuous. Color of body yellowish-green; darker anteriorly, the venter being quite pale. The lines of mature larva barely indicated in faint, rose-brown; the most conspicuous being the broad stigmatal, a narrower one above it, and two which are medio-dorsal. In the better marked specimens, the body above the pale substigmatal line consists of 8 dark and 7 pale lines, the middle pale line medio-dorsal, the second dark one from it most faint and most often obsolete, and the lower or stigmatal one broadest and most conspicuous. Black piliferous dots distinct and normally arranged, i.e., on the middle joints 4 trapezoidally on dorsum; 2 in stigmatal dark line, one just above, the other just behind stigmata; one at lower edge of pale substigmatal line near the middle of the joint, and several that are ventral: the dorsal ones on joints, 1 and 12 forming a reversed trapezoid to those on middle joints; on jt. 11 a square, and on jts. 2 and 3 a transverse line. In the *third stage* there is little change. The head has still a copal yellow aspect, being pale with faint yellowish, brown mottlings, the ocelli still conspicuous. The body is more decidedly striped, the dark stigmatal and pale substigmatal lines more strongly relieved and all the lines approach more to those of last stage. The pale hairs from piliferous dots are still quite noticeable especially before and behind, and the dots themselves are generally relieved by a pale basal annulus. The looping habit is lost, but the front prolegs are still somewhat the smallest. It now curls round and does not spin in dropping. In the *fourth stage* the aspect is quite changed, the general color being dull, dark green. The head has the mottlings of a deeper brown and the characteristic brown lines appear. The second pale line (from above) is obsolete, and the other five are narrowed, pure white, and sharply relieved by dark shades. The prolegs are of nearly equal size; the cervical shield better defined: in short, except in the lighter substigmatal stripe and more greenish color, the characters of the more normal, mature larva obtain. In the *fifth* and *sixth stages* the changes are mainly in the increasing prevalence of the brown and ferruginous colors, and the greater relief and intensity of the black, especially above the upper white lateral line. The front prolegs in the last stage are, if anything, longer than the hind ones. I reproduce herewith, with a few additions, my original description of the

Mature larva.—General color dingy black, appearing finely mottled and speckled under a lens, with the peliferous spots placed in the normal position, but scarcely visible, though the soft hairs arising from them are easily seen with a lens. Four lateral light lines, of almost equal thickness, and at about equal distance from each other, the two uppermost white, the two lowermost yellow; a much less distinct medio-dorsal white line, frequently obsolete in middle of joints, and always most distinct at the divisions: a jet black line immediately above the upper lateral white one, the dorsum near it, thickly mottled with dull yellow, but becoming darker as it approaches the fine dorsal white line, along each side of which it is perfectly black. Space between lateral light lines 1 and 2, from above, dull yellow, or reddish, the white lines being relieved by a darker edge; that between lines 2 and 3 almost black, being but slightly mottled along the middle; that between 3 and 4 yellow, mottled with pink brown, and appearing lighter than that between 1 and 2. Venter greenish-glaucous, mottled and speckled with neutral color, especially near the edge of the 4th lateral line. Legs glassy and of same color as venter, those on thoracic joints with black claws, those on abdomen with a large shiny black spot on the outside. Stigmata oval, black, and placed in the 3d lateral light line. Head highly polished, pale grayish-yellow, speckled with confluent fuscous dots; marked longitudinally by two dark lines that commence at the corners of the mouth, approach each other towards the centre, and again recede behind; on each side are four minute polished black eyelets, placed on a light crescent-shaped ridge, and from each side of this light ridge a dark mark extends more or less among the confluent spots above. Cervical shield polished and mottled like the head, with the white medio-dorsal and upper lateral lines running conspicuously through it. Anal plate obsolete.

These descriptions apply to the average specimens, and, as stated on page 45, there is considerable variation in all stages.

INDEX.

D

E

F

G

H

I

J

K

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M

ERRATA.

Page 34, line 6, for "*Noctuliètes*" read "*Noctuélites.*"
Page 34, line 6, for "three-hundredths" read "two-hundredths."
Page 38, line 6, for "glass" read "grass."
Page 121, line 18, add "and" before "except."

NINTH ANNUAL REPORT

ON THE

NOXIOUS, BENEFICIAL,

AND OTHER

INSECTS

OF THE

STATE OF MISSOURI,

MADE TO THE STATE BOARD OF AGRICULTURE, PURSUANT TO AN APPROPRIATION FOR THIS PURPOSE FROM THE LEGISLATURE OF THE STATE.

BY CHARLES V. RILEY,
State Entomologist.

JEFFERSON CITY:
REGAN AND CARTER, STATE PRINTERS AND BINDERS.
1877.

PREFACE.

To the President and Members of the Missouri State Board of Agricultnre:

GENTLEMEN:—The following pages constitute my Ninth Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri, laid before you in synopsis at your last annual meeting.

During no year since I have been studying the habits of the insects of our State, have the farmers enjoyed such general immunity from insect ravages as during the past year, if we except the work of the Rocky Mountain Locust toward the end of the growing season. This immunity was largely due to the wet character of the summers of 1875 and 1876; for it is a fact that I have frequently laid stress on, that the larger number of the cultivator's worst insect enemies thrive and multiply most during dry seasons. While there was general immunity from insect ravages throughout the State, it was all the greater and more noticeable in the western counties which, in 1875, had been so sorely afflicted. The native locusts were scarce, the Chinch Bug was scarcely heard of, and the general freedom from noxious species, there, which I had anticipated in my Eighth Report, was the subject of remark with all close observers.

It is unnecessary to call particular attention to the subject matter of this Ninth Report, further than to state that a preponderance of space is devoted to that Western scourge, the Rocky Mountain Locust, which again invaded, from the Northwest, most of the fertile country between the Mississippi and the Rocky Mountains, and laid eggs over a larger area than ever before. Reaching our western counties late in the season, the insects did comparatively little damage in Missouri, except to Fall wheat, which was mostly eaten down and killed. They left their eggs, however, and much injury may be anticipated this Spring. A repetition of the ravages of 1875 is probable, but not in the counties most ravaged that year, which will not materially suffer.

The particular counties in which injury may be anticipated are detailed on p. 67. In order that the Report may be distributed among the farmers in those counties in time to be of service to them, I have hastened its publication by omitting articles on the Hessian Fly, the Grape Phylloxera, and some other insects which I had more particularly studied the past year.

In proportion as this Report, and the preceding one for 1875, are circulated in the western counties; in that proportion will the labor bestowed upon them and the experience contained in them prove profitable to the State. I sincerely hope, therefore, that the illiberal spirit manifest in the Twenty-ninth General Assembly, in the attempt to abolish the State Board of Agriculture, and the refusal to make any appropriation therefor, will give place to more generous and enlightened action that will increase rather than diminish the means for usefulness of the only State organization created especially for promoting the farming interests of the State.

In this, as in the previous volumes, when the insects treated of are new, or the existing descriptions of them are imperfect, or in a foreign language, or in works out of print or difficult of access, I have added a full description, which is, however, always printed in smaller type, so that it can be skipped by the non-interested reader. I have endeavored to give a popular name to each insect of economic importance, and this is invariably accompanied, wherever accuracy demands it, by the scientific name, and the latter is generally printed in *italics* and mostly in parenthesis, so that it may be skipped by the practical man without interfering with the text. The Order and Family to which each insect belongs, are generally given under each heading. The dimensions are expressed in inches and the fractional parts of an inch. Where so small, however, as to render such measurement inaccurate, I have adopted the milimeter—one milimeter (1 mm.) not quite equaling twenty-five hundredths of an inch (0.25 inch.) The sign ♂, wherever used, is an abbreviation of the word "male," the sign ♀ for "female," and the sign ☿ for neuter.

Some of the figures are enlarged, but the natural size of each of such is also given or indicated by a hair-line, except in the representation of enlarged structural details, where they are connected with the life-sized insect to which they belong.

The name of the author of the species, and not of the genus, is given as authority; and in order to indicate whether or not the insect was originally described under the generic name which it bears, I have adopted the following plan: When the specific name is coupled with the generic name under which it was first published, the describer's name is attached without a comma—thus indicating the authorship of the dual name: e. g. *Phycita nebulo* Walsh. But when a different generic name is employed than that under which the insect was first described, the authorship is enclosed in parenthesis thus—*Acrobasis nebulo* (Walsh;) except where the whole name is already in parenthesis, when a comma will be used for the same purpose: e. g. (*Acrobasis nebulo*, Walsh.)

All the illustrations, unless otherwise stated, are drawn by myself from nature

Respectfully submitted,

CHARLES V. RILEY,

State Entomologist.

ST. LOUIS, MO., March 14, 1877.

TABLE OF CONTENTS.

INNOXIOUS INSECTS.

NOXIOUS INSECTS.

CURRANT AND GOOSEBERRY WORMS.

The Currant and the Gooseberry, though not among the choicest of our fruits, yet possess, with their peculiarly sub-acid or their spicy flavor, qualities which make them invaluable for the manufacture of jellies and conserves, and render them most grateful and healthful in the hot summer months. Their cultivation is somewhat neglected in Missouri, and though more general farther north and east it has there fallen off within the past twelve or fifteen years, principally on account of the increase of those insects which injuriously affect the plants.

Those, therefore, who desire to successfully grow the Currant and Gooseberry must familiarize themselves with, and learn how to effectually deal with the insect enemies which attack them. Chief among these are several so-called "worms" which prey upon the leaves, and by repeatedly defoliating the bushes, not only prevent the fruit from maturing, but eventually cause the death of the plant. In some sections the injury has been so serious that the culture of these fruits has been abandoned.

It is the common but misleading practice for writers in our horticultural journals to refer to any of these insect enemies of the Currant and Gooseberry as THE Currant Worm or THE Gooseberry Worm, as though there was but a single species injurious to these plants; whereas, in reality, there are quite a number of species that affect them in stem, leaf and fruit. As a rule each requires a different mode of treatment, according to its habit; but I shall here consider only the three principal leaf-feeders, which may all be destroyed by one and the same means.

These three species formed the subject of an editorial article published some years ago in the *American Entomologist* (Vol. II, No. 1) which is now so scarce that it cannot be had in the market. The portion on the Gooseberry Span-worm was written by myself; that on the Currant worms by my associate, B. D. Walsh, the facts in possession of either being interchanged, as was our custom. While I am able to record some interesting observations made since that time, the article was to that extent exhaustive of the subject, that I shall quote liberally from it, rather than recast the facts in different language.

Notwithstanding that the Currant and Gooseberry differ so much in general appearance—the former being a smooth-stemmed shrub, bearing its flowers and fruit in a raceme, while the latter has, as a rule, thorny and prickly stems, and bears its berries singly—they are placed by botanists in the same genus (*Ribes*). Our common Garden Gooseberry (*Ribes grossularia*) was imported from Europe, but we have four wild species commonly found in the Northern States; and besides these four there is a Californian species, the Showy Gooseberry (*R. speciosum*) which is sometimes cultivated as an ornamental plant in our gardens, for the sake of its fine, deep-red, pendant flowers. On the contrary, our common Red Currant (*R. rubrum*), of which the White is a mere variety, is indigenous in the more Northern States, from New Hampshire to Wisconsin, though also a native of Europe; while on the other hand, the Black Currant of our gardens (*R. nigrum*) is a European plant, considered by botanists to be distinct from the American wild Black Currant (*R. floridum*). Besides these, we have three other currants peculiar to America, the Prostrate or Fetid Currant (*R. prostratum*) found in cold Northern woods, the Missouri or Golden Currant, (*R. aureum*) and the Red-flowered Currant (*R. sanguineum*) both of which are natives of the Far West, and are cultivated chiefly for ornament.

These botanical details will not be uninteresting by way of preface to what follows; for the three worms to be described, while they are found indiscriminately on the Red Currant and Gooseberry, are not found on the Black Currant.*

Our Wild Black Currant has a Lepidopterous borer peculiar to it; while the common Currant-borer of our gardens (*Æ. tipuliformis*) which belongs to the very same genus; and the Common Currant Plant-louse (*Aphis ribis*) both confine their attacks to the Red Currant, and do not affect the Black Currant or the Gooseberry. These facts are not only very interesting as showing the slight discrimination

*Mr. Saunders records (*Can. Ent.* II. 147) having found the Imported Currant-worm in the act of feeding not only on the Black Currant, but also on the Plum; but the fact that all larvæ which he endeavored to rear on such leaves eventually died, shows how exceptional and abnormal is their feeding on those plants, and that they cannot, in the true sense of the word, be considered Black Currant or Plum feeders.

which insects sometimes make between plants of the same genus; but they are of much practical importance, as a knowledge of the peculiar tastes and preferences which insects frequently manifest for different species, or even different varieties of plants, will be of much value in guiding us what to plant.

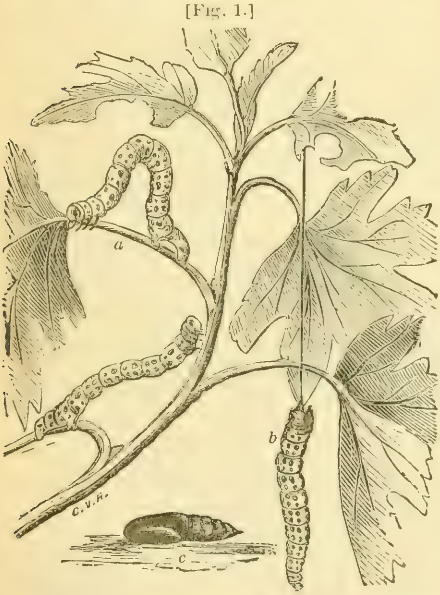
THE GOOSEBERRY SPAN-WORM—*Eufitchia** *ribearia* (Fitch.)

[Ord. LEPIDOPTERA; Fam. GEOMETRIDÆ.]

ITS NATURAL HISTORY.

In the month of May, in the latitude of St. Louis, gooseberry bushes, and more seldom currant bushes, are sometimes suddenly stripped of their leaves by a yellow, black-spotted worm which generally remains unnoticed during the early part of the month, when small and hidden by the foliage. It is the most common and destructive of the gooseberry leaf-eaters in Missouri, and, being a looper or span-worm, is at once distinguished, by its mode of progression, from the other worms to be mentioned. When full grown it measures about an inch, and is of a bright yellow color, with lateral white lines and numerous black spots and round dots, as shown in the accompanying figures. The head is white, with two large black eye-like spots on the outer sides above, and two smaller ones beneath. The six true legs are black and the four prolegs yellow. It drops readily by a web and attains its growth from the end of May to the middle of June, when it descends to the ground and either burrows a little below the surface or hides under any rubbish that may be lying there; but in neither case does it form any cocoon. Shortly after this it changes to a chrys-

[Fig. 1.]

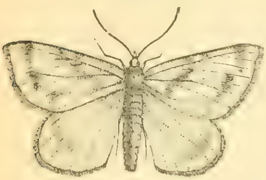


GOOSEBERRY SPAN-WORM:—*a*, *b*, larvæ; *c*, pupa.

*This insect was originally described by Fitch under the generic name *Abraxas*, with a question as to the correctness of the generic reference. It has also been very generally referred to *Ellopia*, but Dr. Packard in his recent admirable *Monograph of the Geometrid Moths*, very properly defines the genus under the name *Eufitchia*, the insect in question being the only species belonging to it.

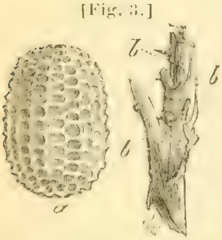
alis (Fig. 1, *c*), of the usual shape, and shining mahogany-brown in color. After remaining in this state about fourteen days, it bursts the chrysalis shell, and in June and the forepart of July appears as a moth (Fig. 2). This last is of a pale nankeen-yellow, the wings rather gauzy and shaded with faintly dusky or leaden-colored spots. These are arranged in no very distinct pattern, but form a more or less conspicuous band across the outer third of all the wings, and give a soiled appearance to the basal portions. The spots are always largest and most intense in the middle portion of each wing. The under surface repeats the upper, and the legs, body and feelers are somewhat brighter, or orange. In the male the feelers are feathered or ciliated; in the female they are simple. These moths may invariably be noticed hanging listlessly about the bushes two or three weeks after the worms have disappeared, and even where the latter have not been numerous enough to attract attention, the moths they have produced may generally be noticed in the month of June, moving with languid flight about the bushes, or darting somewhat more actively from place to place when disturbed. Like the rest of their family, they are nocturnal and, except when aroused, or in cloudy weather, usually remain quiet during the day. The females, soon after issuing from the ground, begin to lay their eggs, fastening them simply to the twigs and more permanent parts of the plant, and principally on the main stems near the ground and beneath the branches. The preference for the inner, more basal and protected portions of the plant, over the terminal or more exposed parts, I have found quite decided. From being laid singly and from possessing protective coloring, these eggs are with difficulty noticed, and have never hitherto been described. I had on several occasions, in years gone by, obtained what were evidently, from comparison with those found in the ovaries, the eggs of this species, but not until last spring did I succeed in hatching therefrom the larvæ, under conditions where they could be watched, or in getting the females to lay in confinement. The egg is irregularly ovoid, slightly compressed, 0.7 mm. long, ⅔ as wide, pale bluish-green in color, with irregular, sub-hexagonal reticulations, so as to give a rather deeply pitted appearance something like the surface of a thimble, there being 15 or more longitudinal rows of these pits. It reminds one in fact of the pitted grain of the berry of *Atropa belladonna*. It is attached as often on one side as on end.

[Fig. 2.]



Female Moth of Gooseberry Span-worm.

[Fig. 3.]



Egg of Gooseberry Span-worm:—*a*, enlarged; *b*, natural size.

This insect is single-brooded, and the eggs are exposed to all the heat of summer, and the vicissitudes of winter, without losing their vitality. At length, when the proper time arrives, and the Gooseberry and Currant unfold their leaves so as to afford plenty of food, these eggs hatch, and in little more than three weeks the worms attain their full larval development.

HOW IT SPREADS.

Owing to the above peculiarity and to the fact that the eggs are attached to the permanent parts of the plant where they are with difficulty seen, the species is frequently carried in the egg state upon transplanted bushes from one neighborhood to another; which accounts for its sudden appearance in parts where it was before unknown.

A NATIVE SPECIES.

This Gooseberry Span-worm is a native American insect, not to be found on the other side of the Atlantic. There is, however, an allied species (*Abraxas grossulariata*), which in Europe infests Currant and Gooseberry bushes in much the same manner as our species does here. The two insects were at one time supposed to be identical, but the European species is at once distinguished by its black, white and yellow markings in the larva and imago states; and by forming its chrysalis above ground. It used to be very common in a dearly-loved garden at Walton, England, where, in watching its metamorphoses I first, as a child, became interested in insect life—the bright colors and striking pattern of the species in all stages, and its external habit, making it a most convenient object for study.

ITS PAST HISTORY.

Our species undoubtedly fed originally on some one or all four of our indigenous gooseberries, but after the introduction of the European gooseberry it very soon manifested its preference for the latter, and, under the new conditions, multiplied so rapidly as soon to become a serious pest. The depredations of this insect in some of the Eastern States, particularly in New York and Pennsylvania, date back a great number of years. In the West it was first noticed by myself (*Prairie Farmer*, July 16, 1875) in the neighborhood of Chicago, in 1862, where for a few years afterward it multiplied to an injurious extent.

In Missouri, my attention was first called to it in May, 1868, by Mr. T. W. Guy, then living at Glenwood. His gooseberry bushes had been entirely denuded of their leaves by it. Mr. Huron Burt of Williamsburg, on May 30, 1870, sent me specimens of the worms, with the statement that they had been defoliating his gooseberry bushes, and that where the foliage was insufficient they would finish up on the fruit. Quite frequently, since then, I have in my travels found the gooseberry bushes in the eastern counties of the State defoliated by this pest; but it is seldom complained of in the western counties, and Mr. Walsh, in the course of twelve years collecting, met with but a solitary specimen of the moth, near Rock Island, Illinois, although the wild gooseberry was abundant in the woods in that locality.

IT PREFERS THE GOOSEBERRY TO THE CURRANT.

This insect shows a decided preference for the Gooseberry, always attacking that plant first when growing side by side with currant bushes. Hence, and because it is generally preferable to apply the popular name of an injurious insect to the state in which it commits its depredations, I have given it the distinguishing term of "Gooseberry Span-worm," though Fitch originally called it the American Currant Moth. The term "Currant Geometer or Measuring Worm" has subsequently been used without any particular reason.

THE MOTH IS CLOSELY IMITATED.

There is another moth common in Missouri and in most parts of the country, which in flight and general appearance bears so close a resemblance to the parent of our Gooseberry Span-worm that the two at first sight are easily confounded, and furnish a remarkable illustration of the fact that insects differing widely in structural details often have stamped upon them the same general appearance, where what naturalists understand as "mimicry" could apparently have had nothing to do in bringing about the resemblance. I refer to a little moth often seen fluttering about the Fragrant Sumach (*Rhus aromatica*) on which its larva perhaps feeds. It has precisely the same color and very much the same markings and differs from the Gooseberry moth only in details of venation, in the simple feelers in both sexes and in the somewhat smaller size, more rounded and more diaphanous wings. It has been referred to an entirely different Family (*Bombycidæ*), but evidently belongs to the Geometers.

PARASITES.

No parasite has been mentioned by previous writers as attacking the Gooseberry Span-worm, but I have reared an undescribed Tachina-fly from its pupa.

REMEDIES.

Many different applications have been used to kill this worm. A correspondent of the *Country Gentleman* (June 17, 1869) mentions having used skim milk with good success. The Gooseberry Span-worm of Europe, already referred to, is fought with a decoction of

Elder leaves boiled until the liquid becomes black. Into this is then mixed an equal quantity of tobacco water. Fox-glove leaves are also used for the same purpose. Sulphide of potassium in dilute solution (one part in 500) is also used in France, and even air-slacked lime is found useful when the worms are young. The same remedies would doubtless apply to our species, but white hellebore, as I shall presently recommend it for the other worms, is most available and most effective, though less satisfactory than when applied to them. The habit which the worms have of letting themselves down by a web when disturbed, renders hand picking quite effectual if done when they are young. It will be most effectual where the bushes are well-trimmed. By shaking these with a forked stick, and then passing the stick under the suspended worms, the latter may be drawn onto the ground and crushed. It is a good plan also to dig around the bushes, after the worms have entered the ground to transform, so as to expose them or the chrysalides to birds. Where practicable, poultry may be used to good advantage in this destruction.

Three other Span-worms* are mentioned by Packard and Saunders as infesting currant bushes; but none of them are spotted and marked as that under consideration, and none of them have ever been known to multiply to the same injurious degree. They all occur in Missouri, and the moths are more often met with than the worms.

THE IMPORTED CURRANT WORM—*Nematus ventricosus*† Klug.

[Ord. HYMENOPTERA; Fam. TENTHREDINIDÆ].

The two insects next to be treated of belong to a class of leaf-feeding worms not heretofore noticed in my Reports, namely, the false caterpillars or slugs. With the exception of the wood-boring Horntails (*Uroceridæ*), and a few of the Gall-flies (*Cynipidæ*), they are the only insects of their order that injure vegetation to any considerable extent. The false-caterpillars are so named on account of their general resemblance to the ordinary caterpillars

Angerona crocataria (Fabr.), *Amphydasis cognataria* Guen., and *Endropia armataria* (H—S.).

†As with so many other insects, this species has received many names, and through the carelessness of describers, and the tendency to erect species on the most trivial differences, it has become almost impossible to unravel its nomenclature. Mr. Walsh has, however, endeavored to do so (*Pract. Ent.* I. 125). The name which I employ, and which has been very generally accepted, was given to it in 1819 by Klug; but as, according to Seibold, Klug's name was what we call a mere museum name, and Scopoli had described the ♂ as early as 1763 (*Entomologia carniolica*, 280) by the name of *ribesii*, the sticklers who allow nothing but the strictest law of priority, carried back to its utmost limit in point of time, will have a chance to fly in the face of modern authors who have employed Klug's name, by adopting Scopoli's, albeit his *ribesii* was a description of but one sex and not of the species. In 1823 the ♂ was described as *affinis* and the ♀ as *trimaculatus* by St. Fargeau; and it is under this last name that Dr. Fitch published an extended article on the species (Trans. N. Y. St. Agr. Soc. 1867, pp. 909-932)—strangely overlooking the sexual distinctions after they had been clearly pointed out by Mr. Walsh. It has at different times been christened *ribis* by two different authors; also *ribesii grossulariæ* and *grossulariatus*.

of moths or butterflies. They are easily distinguished from the latter, however, by never having less than six, and often as many as eight, pairs of prolegs; whereas no true caterpillar has ever more than five pairs. The prolegs also differ structurally in lacking the rim of minute hooks which characterizes those of true caterpillars. The perfect insects are termed Saw-flies, from the peculiar saw-like structure of the ovipositor, which will be more particularly referred to further on.

The species under consideration is one of the most destructive members of the family, and though not so widespread as the Gooseberry Span-worm, it is far more troublesome than any other currant insect in most of the Eastern States. I have neither met with it, nor been able to trace its occurence, with any degree of certainty, in Missouri; but as there is good evidence that it occurs already in Illinois, and Mr. Jno. W. Byrket found it in 1870 around Indianapolis, Ind., I have thought best to forewarn and forearm those of our citizens who are interested in berry culture, by laying before them a full account of it.

ITS INTRODUCTION AND SPREAD.

It first began to attract attention in this country around Rochester, N. Y., about the year 1857—the first explicit reference to it being found in the *Rural New Yorker* for July 24, 1858. It was generally supposed to have been imported along with some gooseberry bushes from Europe, by the celebrated Rochester nurserymen, Messrs. Ellwanger and Barry: but Mr. Barry informed me, while at his beautiful place in 1871, that it was first known to occur around Toronto, in Canada, before it appeared around Rochester.

"In nine years time, besides colonizing in other directions, it had gradually spread to Washington county, N. Y., on the east side of the Hudson River—a total distance of about 225 miles. Thus, as it appears, it traveled at the average rate of some twenty-five miles a year, establishing a permanent colony wherever it went, and not passing through the country as a mere moveable column of invaders. In 1860 or '61 it appeared at Erie, in the N. W. corner of Pennsylvania. In 1864 Prof. Winchell found it at Ann Arbor, Michigan. In 1866 it was generally distributed over the N. E, counties of Pennsylvania. And, judging from a conversation which we had in October, 1868, with Mark Carley, of Champaign, in Central Illinois, this gentleman must have had it in great numbers upon his currant bushes in the summer of that year. At all events he described the worm which had infested his bushes as being green, with many black spots, and as not being a looper.

"But besides the principal centre of distribution at Rochester, N Y., this Currant-worm seems to have been imported from Europe at one or two other points in the Eastern States, and, as at Rochester, to have spread therefrom as from a focus. Unless our memory greatly deceives us, Mr. Geo. Brackett, of Maine, described this same insect many years ago, as existing in that State, though he gave it a different specific name, and was not at all aware that it had been introduced from the other side of the Atlantic. We also heard of it in the summer of 1867, from Mr. A. H. Mills, of Vermont, as being very destructive in his neighborhood. Not improbably, it was independently imported at other points in the East. Wherever it is introduced it spreads with great rapidity, and as there are two broods every year, it soon multiplies so as to strip all the currant and gooseberry bushes bare and utterly ruin the crop, besides eventually destroying the bushes, unless proper measures be taken to counteract it."

According to Dr. Fitch, who, in the article already alluded to, has given a very full account of its spread over the Western States, it kept the bushes so destitute of leaves in most of the gardens at Watertown, N. Y., that in three years they were nearly or quite dead.

It now occurs in all the New England States, and according to Mr. Wm. Saunders, throughout Canada from Halifax to Windsor.

ITS NATURAL HISTORY.

The perfect insects come out of the ground soon after the leaves of the current and gooseberry bushes put forth in spring. The female lays her eggs along the principal veins on the underside of the leaf, (Fig. 4, 1). These eggs, though but slightly attached, yet increase in bulk after deposition, as is the case of all Saw-fly eggs known to me, when inserted into the plant-tissue. Such swelling has been explained heretofore solely on the principle of endosmosis, and if such were the only explanation it would strongly argue that the eggs in this instance, must be slightly inserted in the leaf tissue. Indeed Siebold, in some elaborate observations on this insect, which I shall more particularly refer to further on, finding that the eggs shrivelled and died in measure as the leaves upon which they were deposited dried up, investigated the subject very carefully, and

[Fig. 4]

Imported Currant Worm:—Leaf showing eggs (1), and holes which the young worms make (2, 3.)

declares that the female ruptures, with her weak saws, the epidermis of the leaf-ribs, and thus brings the surface of the egg in very close connection with the exposed parenchyma.*

He further remarks that the rupturing or scratching (Verletzung) which *Nematus ventricosus* causes in ovipositing is "probably confined to the epidermis and may therefore be easily overlooked." This may account for the fact that Mr. Saunders† states, after carefully looking into this matter, that he is fully satisfied that the eggs are not embedded in the leaf tissue at all, but fastened very slightly to the surface. Upon subsequently questioning Mr. Saunders more particularly about it, he wrote (May 25, 1874): "Whatever Siebold may say, I cannot help. My microscope does not show *me* the egg as pushed through the epidermis—it appears distinctly on the surface—it is very different from the Rasberry saw-fly in this respect." Dr. A. S. Packard, Jr., also states (*Embryological Studies* in Mem. Peabody Ac. of Sc., Vol. 1, No. 3,) that the eggs are simply glued to the surface, and this is the experience of all other American writers on the subject. The investigators named are all most careful observers and good microscopists; yet either there is error somewhere, or else, which is an interresting possibility, the insect has been modified in habit since its introduction to America.

While in the majority of cases in America, as observed by Saunders and Packard, the abortive saws of the female may not rupture the epidermis; in some cases, however, they certainly do; for in most but not all the specimens which I have examined, I have detected the slight rupturing mentioned by Siebold. It is still plainly discernible in a dried leaf now before me from Mr. J. A. Lintner, of Albany, N.Y., and yet containing well formed eggs that were parasitized. Nevertheless, when made, it is so slight as to be altogether insufficient to support the egg without the adhesive fluid that accompanies it. The eggs, while attached, appear no more inserted than are those of the genus *Lyda*, and differ materially in this respect from those of all other Saw-flies known to me.

Siebold himself remarks that there can be, with such slight skinning of the epidermis, but little vital intercourse between the egg and the plant, and the facts that I have recorded as to the swelling of the eggs of our Katydids when fastened to perfectly dry and dead substances (Rep. V, 124,) would indicate that the swelling is not due solely to endosmosis from the attached parts of the plant, but depends on another principle, difficult to analyze, but evidently more or less atmospheric.

*Beitr. zur Parthenogenesis der Arthropoden, 1871, p. 123.

†*Am. Entomologist* II, 274; *Can. Ent*, II, 112.

Mr. Saunders has found as many as 101 eggs on three contiguous leaves.

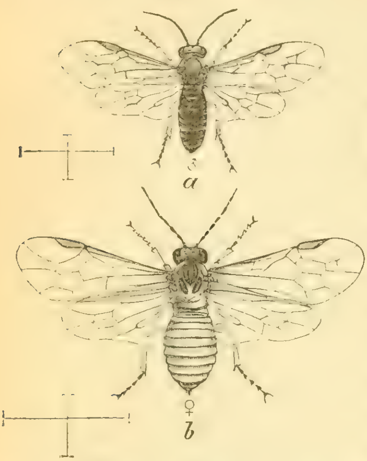
The eggs hatch within a week or ten days according to the weather, into pale 20-legged larvæ with a large dull whitish head, having each side the black spot so characteristic of Saw-fly larvæ belonging to the same genus. The color soon becomes green, and as the worms molt they acquire black, shiny spots on the body, and a black head. After the last molt the spots are shed again, and the color is entirely grass-green, except the dark head-spots, and a yellowish tinge on the first and the anal joints. In the annexed Figure 5, *a*, *a*, *a*, *a*, show larvæ of different sizes in different positions; and *b* gives an enlarged view of one of the abdominal joints in profile, so as to exhibit the position of the black spots. "When full-grown the larvæ are about three quarters of an inch long, and from their greatly increased size, make their presence readily known by the sudden disappearance of the leaves from the infested bushes. Shortly afterwards, having attained a length of fully three-quarters of an inch, they burrow under-ground, generally beneath the infested bushes, or, if there are many leaves lying on the ground, simply hide under those leaves. In either case they spin around themselves a thin oval cocoon of brown silk, within which they assume the pupa state." Frequently, however, as has been fully proved by Mr. Saunders, and as has been recorded by European observers, they form their cocoons in the open air, on the bushes, or under any extraneous shelter that is at hand. "About the last week in June or the first part of July, or occasionally not until the beginning of August, the winged insect bursts forth from the cocoon and emerges to the light of day; when the same process of coupling and laying eggs is repeated. The larvæ hatch out from this second laying of eggs as before, feed on the leaves as before, and spin their cocoons as before; but the perfect fly from this second brood does not come out of the coccoon till the following spring, when the same series of phenomena is repeated." At least such is the case ordinarily, though a third generation is sometimes produced.

[Fig. 5.]

IMPORTED CURRANT WORM:—*a*, *a*, *a*, larvæ; *b*, a magnified joint of body, showing black tubercles.

Mr. Saunders has given some reason to believe that a few of the second brood of larvæ may exceptionally hibernate as such.* This in itself is not impossible, but cannot, by any means, be looked upon as proved. The impression rests on the fact that on the 31st of May, 1869, he found a cocoon attached to a bag which he had tied on a gooseberry bush on the 22d of the same month. We all know that the Gooseberry is one of the first plants to blossom and leaf, and that in all ordinary seasons a worm such as our Currant-worm would have ample time to acquire full growth by the last of May at London, Ont. In point of fact Mr. Saunders himself found worms feeding the very next year in the very same locality, as early as the 10th of May.† Yet he could not suppose these had hibernated because he at the same time found eggs upon the leaves, some of which must have been laid two weeks earlier. The flies are known to issue in April even in Northwestern New York, where, though on about the same latitude, the opening of spring is later than at London, Ont. Moreover, in the very first article appearing upon the insect in this country (*Rural New Yorker*, June 24, 1858), the worms are described as appearing "in succession occasionally from March till October, but in greatest numbers in June." And, allowing the spring of 1869 to be unusually late, I cannot see why a cocoon found the last day of May should not have been made by a worm hatched from an egg deposited by an early developed fly; for it is more likely that an early female should deposit a few eggs on the yet unfolded buds than that the worm should, as such, weather the winter's severity except when shielded by its cocoon.

[Fig. 6.]



IMPORTED CURRANT WORM:—*a*, male; *b*, female fly, the hair lines showing nat. size.

"From the drawings of the male and female‡ fly given herewith (Fig. 6), the reader will see at once that the two sexes differ very widely. This is very generally the case among the Saw-flies, and it is a remarkable and most suggestive fact that, when this takes place, the body of the male is almost invariably darker than that of the female. Nor does our species, as will be observed at the first glance, form any exception to the rule." Indeed, as with several other species and

Can. Ent., II, pp. 16, 48.

†*Ibid*, p. 112.

‡The abdomen in this cut should show only 9 joints.

notably the saw-flies (genus *Lophyrus*) which affect the White Pines and which will be treated of further on, the body of the male is almost entirely black and that of the female almost entirely yellow.

PREVENTIVE MEASURES.

"The mode in which this Currant-worm has been transmitted, first from the European nursery to the American nursery, and afterwards all over several States of the Union, can be easily explained. As has been stated just now, it usually passes the autumn and winter in the ground under the bushes, where it has fed, housed in a little oval cocoon from $\frac{1}{4}$ to $\frac{1}{3}$ inch long. Hence if, as often happens, infested bushes are taken up in the autumn or early in the spring, with a little dirt adhering to their roots, and sent off to a distance, that dirt will likely enough enclose a cocoon or two. A single pair of cocoons, if they happen to contain individuals of opposite sexes, will be sufficient to start a new colony. The first and probably the second year the larvæ will not be noticed; but increasing as almost all insects do, unless checked from some extraneous source, in a fearfully rapid geometric progression, by the third or fourth year they will swarm, strip the bushes completely bare of their leaves, and ruin the prospect for a good crop of fruit. Of course, like other winged insects, they can fly from garden to garden in search of a suitable spot whereon to deposit their eggs; so that any point where they have been once imported becomes, in a few years, a new centre of distribution for the immediate neighborhood.

"Nurserymen and all others, importing Gooseberry and Currant bushes from a distance, should be particularly careful, before they plant them, *to wash the roots thoroughly in a tub of water, and burn or scald whatever comes off them.* Any cocoons, that may happen to be hidden among the dirt attached to the roots, will then be destroyed."

By adopting these precautions the dissemination of so mischievous a pest throughout the country, and especially its introduction into Missouri, might be prevented for many years to come.

REMEDIES.

White hellebore, which can be had at a comparatively low price, has proved an infallible remedy for this worm.

"All that is required is to dust it lightly over the infested bushes, taking care to stand to windward during the operation, as if taken into the nostrils it excites violent sneezing. For this purpose, the best plan is to put the powder into a common tin cup, tying a piece of very fine muslin over the mouth of the cup; or the powder may be simply enclosed in a bag of muslin of convenient size. In either case, the apparatus must be fastened to the end of a short stick, so as to avoid coming in too close quarters with it. It is best to select a moderately still day for the operation; as the powder is so exceedingly fine that on a windy day it is apt to get wasted."

It may be more safely and agreeably, and just as effectually applied in solution, by syringe or sprinkler, in proportion of one pound of the powder to 20 or 25 gallons of water.

"To test the genuineness of the article, a very small pinch of it should be applied to the nose. If it is good and has not lost its strength by keeping too long, it will immediately produce a tingling sensation in the nostrils; if it does not produce this effect, it is worthless and should not be used. There is every reason to believe that in those cases where men have used White hellebore to kill Currant Worms without any preceptible effect, they had been deceived into buying an adulterated or worthless drug. Although, like almost all our medicines, hellebore, in large doses, is poisonous, yet in minute doses there is no reason to be afraid of it; for, according to Dr. Fitch, it has long been in use as the basis of those snuffs, which are designed to excite violent and continued sneezing."

The following interesting experience with hellebore in solution, and with hot water, is given by Mr. Saunders in the *Canadian Entomologist* (Vol. II, pp. 13–15), and will prove instructive.

The larva of *Nematus ventricosus*, alas, too well known under the popular designation of "currant-worm,"* has been very abundant in this neighborhood during the present season. In my own garden it has been a continual fight as to who should have the currant and gooseberry bushes, the worms or their rightful owner. During the early part of summer, anticipating their attack, I was on the lookout for them and by timely doses of hellebore, preserved the foliage with but little damage. In about a fortnight later, having omitted inspection for a few days, I was surprised to find the bushes being stripped again; and this time the enemy had got so far ahead as to damage their appearance considerably. Another prompt dosing of hellebore brought relief. After this I hardly ever found all the bushes entirely free from them; a walk around the garden would reveal a few here and a few there, and I was perpetually hand-killing and brushing off these smaller detachments. Four times during the season I found it necessary to apply hellebore freely, for the foes were a legion.

During the middle of August, being occupied with other matters, the garden was neglected for a few days, when on visiting it again on the 19th, I found many of the bushes entirely leafless, and the foliage remaining on the others was rapidly disappearing. I felt discouraged and began to have some misgiving as to whether hellebore was after all such an unfailing panacea for this almost universal pest as we had supposed. I resolved if possible to satisfy myself fully on this point, and having mixed about $1\frac{1}{2}$ oz of powdered hellebore with a pail of water, was ready to proceed. I selected a leaf from two bushes, marked them and counted the number of their inhabitants—one was occupied by *forty-four* worms of different sizes, crowding it above and below, and it was about half eaten; the other leaf had twelve nearly full grown on it. Having transferred the mixture of hellebore and water to a watering pot, the bushes were sprinkled with it. I returned to examine the results in three-quarters of an hour, and the leaf which at first had forty-four on it, had now only two, and these were so far exhausted that they were unable to eat, and could hardly crawl,

* After this admission, it seems to me that the popular distinguishing term of "Imported Currant-Worm," first given it by Walsh, is preferable both to that of "Imported Gooseberry Saw-fly," given by Mr. Saunders (Rep. Ent. Soc. Ontario, 1871), and to that of "Currant Worm and Saw-fly" bestowed by Dr. Fitch.

while on the other leaf out of the twelve there remained three, but in the same enfeebled condition. All around under the bushes, the ground was strewed with the fallen foe, and I felt perfectly satisfied that entite reliance might be placed on this means of defense.

I did not anticipate such speedy action on the part of the hellebore, or should have returned to the examination sooner, and the bushes were so entirely cleared, that, excepting on one I had reserved for another experiment, I had no means of repeating the dose.

There was one thing that struck me as somewhat remarkable, the portion of leaf on which the greatest number were feeding, appeared to be of the same size as before the hellebore was applied; if smaller I could not perceive it. When the leaves dry, which have been sprinkled with liquid, a very thin coating of the powder, more or less regular, is found over them, and I had always supposed that death resulted from eating a portion of the leaf thus coated. Such is undoubtedly the case when the hellebore is applied dry, but in this case a meal however small made by *forty-four caterpillars* on half a leaf, must have materially diminished it. I am disposed to believe then that the death of most of these must have resulted from their imbibing or absorbing some of the liquid as soon as applied. Many of them showed symptoms of the violent cathartic action of the remedy, having a mass of soft excrement hanging to the extremity of their dead bodies.

I had reserved one bush, on which were a good number, for another experiment. It sometimes happens, especially with those who live in the country, that hellebore is not at hand when the worms are first observed at work, and a few days' delay in procuring it is perhaps unavoidable. In such cases the bushes may be entirely leafless, before the remedy can be applied. Hot water suggested itself to my mind as likely to be of some service, and being also an article readily procurable in every home. It is well known that many plants will bear such an application without injury, provided the heat is not too great. Taking some in a watering pot, a little hotter than one could bear the hand in, I showered it plentifully on the affected bush, and it was amusing to see how the caterpillars wriggled and twisted and quickly letting go their hold, fell to the ground, which was soon strewed with them. After the first excitement produced by the sudden heat was over, they remained as if wishing to "cool off" before commencing work again. A few did not recover from the application, but most of them were soon as acuve as ever.

Now what I would suggest is this, that where the hellebore cannot be at once procured, no time should be lost in applying the hot water, and when once on the ground the creatures may have the life trodden out of them by the foot, or beaten out with the spade or some other implement. In any case many of them would never reach the bush again, for enemies beset them on every side.

If used in powder, a perforated tin cylinder, such as is commonly used for the purpose in England, will be found useful to push into the bushes and reach every part thereof, and particularly the under sides of the leaves. It is generally made about $2\frac{1}{2}$ inches wide and 10 inches long. The cylinder has a fixed bottom, with a socket to receive a handle and a brace to strengthen the socket, and a tight-fitting cover completes it.

As the well known editor of the *American Agriculturist* writes from his own experience: "A pound of white hellebore, costing about forty cents, will clean any ordinary garden, and keep it clean for a season. If applied in the liquid form with a good syringe, the whole labor need not exceed an hour. There is great satisfaction in seeing clean bushes and clean clusters, and though it may be an evidence of depravity, we confess to a feeling of consolation at the sight of the enemy, stupefied, coiled up, and laid out in rows upon the brown earth. We always did have a private interpretation of Cowper's sentiment about 'needlessly setting foot on a worm.'"

Numerous other remedies might be detailed, some of which, as copperas water, decoction of poke weed root, etc., have doubtless proved more or less effectual, but most of which are founded on isolated experiments and on results due to other causes which the experimenters did not understand. Indeed, one can scarcely pick up a horticultural journal without finding during the summer months some new remedy for THE Currant-worm recommended. But nothing equals those I have referred to, and even carbolate of lime, which is quoted by many authors as having been used with success by Dr. E. Worcester, of Waltham, Mass., and as being less disagreeable, less costly and perfectly safe, was, after thorough trial, found by Mr. Saunders, who is himself a chemist, and doubtless obtained the pure article, to be of little or no avail. The only manner in which it can be successfully employed, as Mr. M. W. Armington, of Providence, R. I., maintains, is by sprinkling it on the ground, and then shaking the worms down, when, if of full strength, it will prevent most of them from getting back.

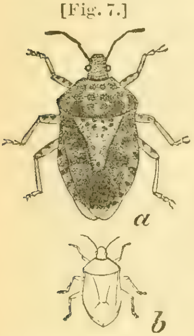
From the habit which belongs to this species of laying the eggs in large numbers on a single leaf, we can employ another means of counter-working its injuries which will not apply to the other two worms. The newly hatched larvæ can find "plenty of food without wandering off, and they have the habit when very young of boring small holes through the leaf, as shown at No. 2 in Figure 4, and when they become a little older, holes that are a little larger, as shown at No. 3. It is evident that such holes as these may be readily recognized, and the leaf be carried, larvæ and all, far away from any currant or gooseberry bushes, and left to winter there, or—to make assurance doubly sure—thrown into the fire. If, however, the young larvæ are removed a few rods away from any plant belonging to the botanical genus *Ribes,* they will be sure to die of starvation. For they cannot feed on anything else, any more than the common Locust-borer can live on an apple tree. As the eggs are laid in such large groups, there will be but a few leaves bearing these newly hatched larvæ to remove from every bush," and early in the season they will be found principally on the lower parts of the bushes, nearest the ground.

"Wherever this Currant Worm has been introduced, there has prevailed, from some cause or other, a popular superstition that the currants grown upon the infested bushes are poisonous. This is a mere delusion. They may be, and very probably are, unwholesome, just as any other fruit would be perhaps more or less unwholesome, if grown under such unnatural conditions as to seriously affect the health of the tree; but we have the authority of Dr. Fitch, himself a physician, for believing that the common notion on this subject is entirely erroneous."

NATURAL ENEMIES.

It is not probable that any of the natural enemies which attack this insect in Europe have been imported with it into this country; but several of our indigenous species have learned to prey upon it. Besides such indiscriminate feeders as ants and some of the cannibal beetles which Mr. Saunders has observed to attack the worms when they fall from the bushes, or are the least helpless or injured, it is attacked while on the bushes and in vigorous health by a Half-wing Bug, first noticed at this work by the same gentleman. This species (*Podisus placidus* Uhler, Fig. 7, *a*, enlarged; *b*, natural size) which may be called the Placid Soldier-bug, is marked with yellowish-brown and dark brown, and attacks the worms in the same well known manner in which the Spined Soldier-bug spears and sucks to death the larvæ of the Colorado Potato-beetle. Mr. Walsh bred from this Currant worm a small Ichneumon-fly (*Brachypterus micropterus*, Say) which has such small wings that it much resembles an ant. Mr. C. J. S. Bethune also reared from its cocoon another Ichneumon-fly (*Hemiteles nemativorus*, Walsh)* closely allied to that which infests our common Bag Worm (Rep. I, p. 150.) This same fly was captured a number of years ago by Mr. Walsh around Rock Island, Illinois, "and as the Imported Currant Worm has not as yet been introduced into that region, we must conclude that this Ichneumon-fly could not have been imported into America from Europe along with this Currant Worm, but that in all probability it is an indigenous species. Hence we have additional proof that, under certain circumstances, native American parasites can, and actually do, acquire the habit of preying upon European insects when the latter are imported into America. It is certain, however, that they will not do so in all cases without exception; for although the Wheat Midge, or Red Weevil, as it is incorrectly termed in the West, invaded our shores some forty or fifty years ago, not a single parasite has yet been discovered to prey upon it in this country, although there are no less than three that prey upon it in Europe."

[Fig. 7.]



PLACID SOLDIER-BUG: *a*, enlarged; *b*, natural size.

Lastly, Mr. J. A. Lintner has discovered that even the eggs are inhabited by a minute Hymenopterous parasite which, I believe, remains undescribed; and he informs me that he has also bred a Tachina-fly from the larva.

* *Can. Entomologist*, II, page 9.

IT PRESENTS A FORCIBLE EXAMPLE OF ARRENOTOKY.

Parthenogenesis, or the production of offspring by virgin females, has long been recognised as a zoölogical fact, occurring with many of the lower forms of animal life, and not unfrequently with insects. With many of the latter, *e. g.*, the plant-lice, as we have so fully seen in these Reports in the case of the Grape Phylloxera, it is the normal form of reproduction; while with many other insects, as with some, and perhaps with most gall-flies (*Cynipidæ*), it occurs regularly at every alternate generation. It also occurs occasionally with insects which normally cannot or do not multiply without direct sexual intercourse, as in the common Mulberry Silk-worm. As I have remarked elsewhere:* "What in some species is the exception, becomes the rule in others, of which the hive-bee is an example. The male element may be said to possess all degrees of potency in its influence on the reproductive functions of its immediate issue, as the embryo in ova not directly fecundated, attains all degrees of development before death. In cases of parthenogenesis it is potent enough—vital enough, to cause full development of the offspring for one or more generations, though in the majority of instances, and especially where this mode of reproduction does not occur as a rule, this offspring is most frequently male." In other cases females instead of males are produced. The power possessed by the virgin females of certain species to produce male offspring, has been called Arrenotoky by Leuckart; while the parthenogenetic production of females has been designated as Thelytoky by Siebold, who has elaborately shown† that our Imported Currant Worm possesses the former power, and that the unimpregnated eggs hatch into larvæ which produce male flies. Further, that this is the rule with all its eggs non-impregnated, which seem to hatch fully as well as those which are impregnated. This power, as Siebold shows, had been observed as far back as 1831, by Robert Thom, who, in Loudon's *Gardener Magazine* (Vol. VII, p. 196), states, that "the ova of the female produce caterpillars, even when the male and female flies are kept separate;" but who, loth to believe in anything so extraordinary as *lucina sine concubitu* must have seemed in those days, thought that there was "reason to suspect that there is a connection between the male and female caterpillars," from the fact that these, as is so often the case with the Saw-fly larvæ, are not unfrequently found with their tails curled around each other. Thus arrenotoky occurs in our Currant Worm (Fam. *Tenthredinidæ*), as it does in the Hive-bee (Fam. *Apidæ*). It is also known to occur among wasps

**Am. Naturalist*, Vol. VII, p. 520.

†*Beitr. zur Parthenogenesis, &c.*, 106—130.

(*Vespidæ*). With certain moths belonging to the family *Psychidæ*, and with certain crustaceans, only thelytokic parthenogenesis takes place.

IT ALSO FURNISHES AN INTERESTING INSTANCE OF DEFUNCTIONATION OF SPECIAL PARTS.

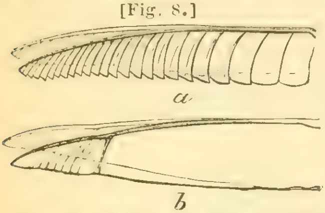
As already remarked (ante p. 8), the Saw-fly family to which our insect belongs, derives its name from the peculiar structure of the ovipositor, which looks like the blade of a saw.

"Under the microscope—and in the larger species, even under a good lens—it will be seen that the lower edge of each of the two horny blades, of which this instrument is composed, is furnished with very fine teeth, the shape of which differs in different species. With this tool the female fly saws into the texture of the leaf or of the twig, in which the instinct of each particular species teaches it to deposit its eggs; and—wonderful to relate—it was demonstrated long ago that the eggs thus deposited inside the substance of the plant, which is to supply the future food to the young larva as soon as it hatches out, actually grow and derive nourishment from the sap of that plant, so as often to attain double their original size.* Hence we may see at once why the eggs are deposited by this group of insects in such situations as these, and why Nature has provided the female Saw-flies with saws in their tails. But—as the thoughtful reader will perhaps have already observed—our Currant-worm Fly lays its eggs upon the surface, and not in the interior of the leaf, glueing them thereto by some adhesive fluid, which it secretes for that purpose." At the most in some instances, she scratches the epidermis. "And we may add that there are a few other Saw-flies—such for example as the Rosebush Saw-fly (*Selandria rosæ*)—which do the very same thing, and consequently, as well as our species, can have little use for any saws at their tails. If, therefore, as was formerly the almost universal belief of the scientific world, each species, whether of animals or of plants, was independently created, with all its present organs and instincts, and not derived, as is the more modern doctrine, from the gradual modification of pre-existing species through a long series of geological ages, we might naturally expect our Currant-worm Fly, and the Rosebush Saw-fly and such few other Saw-flies as practice similar modes of laying their eggs, to have no saws at all. For why should Nature, when she is creating new species, bestow an instrument upon a particular species which has no occasion whatever to use that instrument? In point of fact, however, all female Saw-flies, no matter what their habits

*I have already stated my opinion that this enlargement is not due solely to nourishment from the sap.

may be, possess these saws, though in one genus (*Xycla*) the saws, instead of being hard and horny throughout, are said to be soft and membranous above and below;* and in certain other Saw-flies, though they are as hard and horny as usual, they are degraded and—to use the technical term—'defunctionated.' This will be seen at once from an inspection of the following drawing (Fig. 8), copied by ourselves from nature and very highly magnified. Here *a* represents the two saws of the female of the Willow-apple Saw-fly (*Nematus salicispomum* Walsh), which belongs to the very same genus as our Currant-worm Fly. Now, we know that the female of the Willow-apple Saw-fly deposits a single egg inside the leaf of the Heart-shaped Willow (*Salix cordata*) about the end of April, probably accompanying the egg by a drop of some peculiar poisonous fluid. Shortly afterwards there gradually develops from the wound a round fleshy gall, about half an inch in diameter, and with a cheek as smooth and rosy as that of a miniature apple; inside which the larva hatches out and upon the flesh of which it feeds. In this particular case, therefore, as the female fly requires a complete saw with which to cut into the willow leaf, nature has supplied her with such saws, as is seen at once from Figure 8, *a*. Now look at Figure 8, *b*, which is an accurate representation under the microscope of the two saws of our Currant-worm Fly. It will be noticed at the first glance that, although the blade of the saw is there, the teeth of the saw are almost entirely absent.

[Fig. 8.]



OVIPOSITORS OF SAW-FLIES:—*a*, perfect; *b*, imperfect.

What, then, are we to make of these and many other such facts? Manifestly the teeth of the saw are in this last species degraded or reduced to almost nothing, because the female fly, laying her eggs upon the surface of the leaf, and not cutting into the substance of the leaf, as does the female of the Willow-apple Saw-fly, has no occasion to perform any sawing process. But why, it will be asked, is the blade of the saw there in its normal size, and with the exception of the degradation of the saw-teeth, as completely developed as in the other species, when such a tool cannot be necessary for the simple process of glueing an egg on to the surface of a leaf? The modern school of philosophers will reply, that this is so, because the primordial Saw-fly, in the dim far-away vista of by-gone geological ages, had a complete pair of saws, and our insect is the lineal descendant of that species, slowly and gradually modified through a long series of years, so as to

*See Westwood's *Introduction*, II, p. 95.

conform more or less to the change in its habits. On the other hand the old school of philosophers, who believe that every species was independently created, will argue that this is so, in order to 'complete the System of Nature,' and 'carry out the Plan of the Creation,' and 'give full and free expression to the Thoughts of the Creator.' Possibly this may be the true solution of the difficulty; but—and we say it in no irreverent spirit—what should we think of a Potter, who made all his teacups, without exception, with handles; those for which handles were required with complete ones such as you could put your finger through, and such cups as were not wanted to have any handles at all, with solid unperforated ones, such as would be nearly useless? And what should we say, if the Potter's friends were to gravely argue, that he took all this unnecessary trouble in order 'to complete the System of Art,' and 'carry out the Plan of the Tea drinker,' and 'give full and free expression to the Thoughts of the Potter?'"

DESCRIPTIVE.

I repeat the following descriptions as originally drawn up by Mr. Walsh from many specimens, as the publications in which they occur are not now very accessible.

As I have already stated, the larva is pale green just previous to spinning its cocoon, having thrown off the tubercled skin with the last larval molt. Indeed this habit of throwing off the armed or ornamented larval skin before preparing for the pupa state is almost universal with the Tenthredinidæ. The comparatively naked condition, between the full grown larval and pupal states, may be likened to the semi-pupa state of some other insects, for the Saw-fly larvæ in this condition shrink somewhat in size and do not feed, as far as I have observed, though they may be active for a few days.

NEMATUS VENTRICOSUS—*Larva, nearly mature.*—Length ¾ inch. Pale green, verging on yellow towards the tail. Head black, polished, with numerous short hairs proceeding from minute tubercles. Mouth, except the mandibles, dingy green. Joints of the body above with rows of small shining black tubercles placed crossways, and each bearing a hair in the less mature specimens, but in the largest and most mature ones bearing no hairs at all, except the larger tubercles on the sides. First joint behind the head with a single row of dorsal tubercles; joints 2 and 3 each with a double row, the anterior one curved forwards in the middle in a semicircle; joints 4—12 with a treble row; the anal plate black, polished, and prolonged at each posterior angle in a slender acute thorn, and having, besides the triple row of tubercles before it, a group of six or eight tubercles on each side of and partly before it. A longitudinal row of larger lateral black tubercles on joints 2—12, one on each joint, beneath which there is a geminate black tubercle above each proleg; all these tubercles bearing many hairs. Legs black, the sutures pale green. Prolegs fourteen, pale green, all but the two anal ones with a few minute black dots towards their tip in front. Joints 4 and 11 without prolegs.

Female Fly.—General color of body bright honey-yello. *Head* black, with all the parts between and below the origin of the antennæ, except the tip of the mandibles, dull honey-yellow. Antennæ brown-black, often tinged with rufous above, except towards the base, and beneath entirely dull rufous, except the two basal joints; four-fifths as long as the body; joint 3, when viewed laterally, four times as long as wide, joints 3–5 equal in lenth, 6–9 very slowly shorter and shorter. In two females the antennæ are 10-jointed, joint 10 slender and ⅝ as long as 9. *Thorax* with the anterior lobe above, a wide stripe on the disk of each lateral lobe which is very rarely reduced to a mere dot, or very rarely the whole of each lateral lobe, a spot at the base and at the tip of the scutel, the two spots sometimes confluent and very rarely subobsolete, a small spot at the outer end of each cenchrus and a geminate small spot transversely arranged between the cenchri, the tip of the metathoracic scutel, the front and hind edge above of what seems the 1st abdominal joint, but is in reality the hind part of the metathorax, or very rarely its whole surface above, and also the whole lower surface of the breast between the front and middle legs, or very rarely two large spots arranged crossways on that surface, all black. Cenchri whitish. *Abdomen* with joints 1 and 2 very rarely edged at tip with black. Sheaths of the ovipositor tipped more or less with black, the surrounding parts sometimes more or less tinged with dusky. The triangular membrane at the base of the abdomen above, whitish. *Legs* bright honey-yellow; all the coxæ and trochanters whitish; the extreme tip of the hind shanks and the whole of the hind tarsi, brown-black. *Wings* glassy; veins and stigma brown-black, the latter as well as the costa obscurely marked with dull honey-yellow. In a single ♀ all three submarginal cross-veins are absent in one wing, and only the basal one is present in the other wing. In another ♀ all three are indistinctly present in one wing, and in the other only the basal one and a rudiment of the terminal one. In a single wing of two other ♀, the terminal submarginal cross-vein is absent. And in a single ♀ there are but three submarginal cells in either wing, precisely as in the genus *Euura*.—Length ♀ 0.22—0.28 inch. Front wing ♀ 0.27—0.33 inch. Expanse of wings ♀ 0.53—0.64 inch, (wings depressed).

Male Fly.—General color of body black. *Head*, with the clypeus and the entire mouth, except the tip of the mandibles, dull honey-yellow. Antennæ brown-black, often more or less tinged with rufous beneath, except towards the base; as long as the body, the joints proportioned as in ♀, but the whole antenna, as usual in this sex, vertically much more dilated, so that joint 3 is only 2½ times as long as wide when viewed in profile. *Thorax* with the wing-scales and the entire collare honey-yellow. Cenchri whitish. *Abdomen* with more or less of its sides, the extreme tip above, and its entire inferior surface honey-yellow. *Legs* as in ♀. *Wings* as in ♀. In two ♂ the middle submarginal cross-vein is absent in both wings, so that if captured at large they would naturally be referred to the genus *Euura*. In two other ♂ this is the case in one wing only. Another ♂ has but the basal submarginal cross-vein remaining in each wing. And in two other ♂ the terminal submarginal cross-vein is absent in one wing. Length ♂ 0.20—0.22 inch. Front wing ♂ 0.23—0.25 inch. Expanse of wings ♂ 0.44—0.54 inch, (wings depressed.)

" Described from 22 ♂ and 13 ♀, 3 ♂ and 1 ♀ of the spring brood. The fact of two ♀, contrary to the established character of the genus *Nematus*, having 10-jointed instead of 9-jointed antennæ is a variation of a kind of which no other example in the whole family of Saw-flies is on record. Had such a specimen been captured at large, instead of being bred along with a lot of normal ♀, from the same lot of larvæ taken from the same lot of bushes, it would probably have been made the basis of a new genus."

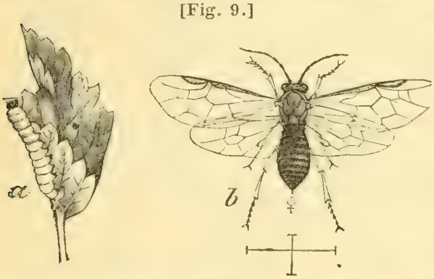
THE NATIVE CURRANT-WORM—*Pristiphora grossulariæ* Walsh.

[Ord. HYMENOPTERA; Fam. TENTHREDINIDÆ.]

WHEREIN IT DIFFERS FROM THE IMPORTED SPECIES.

"Like the Imported Currant-worm, this worm produces a Saw-fly, which, however, belongs to a different genus, (*Pristiphora*), chiefly distinguishable from the other one (*Nematus*) by the front wing lacking what is technically termed the 'first submarginal cross-vein.' In Figure 9, *b*, we give a magnified drawing of the female of this fly, and if the reader will look at this drawing and compare it with that of the Imported Currant-worm Fly (Fig. 6, *a* and *b*), he will see that there is in each of them but one cell, or 'pane' as it might be termed, on the upper edge of the front wing towards its tip. This is technically called 'the marginal (or radial) cell.' Now let the reader look a second time at these two figures, and he will see that, underneath this 'marginal cell' there is a tier of four cells in the one genus (*Nematus*) and a tier of only three cells in the other genus (*Pristiphora*), the first or basal cross-vein being absent or 'obsolete' in the latter, so as to leave the first or basal cell extravagantly large. These three or four cells, as they underlie the 'marginal cell,' are technically known as 'the submarginal (or cubital) cells;' and upon the difference in the number and arrangement of these marginal and submarginal cells depends to a considerable extent the generic classification of the Saw-flies. For example, in another genus (*Euura*), which is closely allied to the two of which we present drawings, there are, as in the second of these two, one marginal and three submarginal cells; but here it is the *second*, not the *first* (or basal) submarginal cross-vein that is obsolete; so that here it is the *second*, not the *first* (or basal) submarginal cell that is extravagantly large, being formed in this last case by throwing the typical second and third cells into one, and in the other case by throwing the typical first and second cells into one, just as by removing the folding doors two rooms are thrown into one.

[Fig. 9.]



NATIVE CURRANT-WORM:—*a*, larva, nat. size; *b*, fly, enlarged.

"Persons who are not familiar with this subject are apt to suppose, that the pattern of the curious network on every fly's wing varies indefinitely in different individuals belonging to the same species, As a general rule, there is scarcely any variation at all in this matter, each species and even each genus having its peculiar pattern, and all the individuals belonging to a particular species having the network of their wings as exactly similar as the different photographs executed by a daguerreotypist from the same negative plate. You may take, for instance a thousand, honey-bees, and you will find that in the front wing of every one of them there are exactly one marginal and three submarginal cells, which, however, are all of them shaped very differently from the corresponding cells in any Saw-fly, though all the thousand honey-bees will be found to have them shaped exactly alike, cell corresponding to cell, as in any particular issue of $5 bank notes, vignette corresponding to vignette and medallion die to medallion die. Among the Saw-flies, indeed, as was noticed in the description of the Imported Currant-worm Fly, the pattern of the wing-veins in different specimens of the same species varies occasionally a little; but this is the exception and not the rule, and is philosophically of high interest, as showing how one genus may in the course of indefinite ages change gradually into another genus.

"The Native Currant-worm Fly differs in another remarkable point from the Imported Currant-worm Fly. The sexes are here almost exactly alike in their coloration, and with the exception of the legs of the male being a little more marked with black than those of the female, it would not be very easy to distinguish one from the other, but by the usual sexual characters. Hence we have not thought it necessary to give a figure of the male as well as of the female; whereas in the Imported species the two sexes differ so essentially in their coloration that, as already observed, a figure of one would give scarcely an idea of the other."

ITS HABITS.

"The larva of the Native Currant-worm Fly (Fig. 9, *a*) is of a uniform pale green color, without those black dottings which are always found, except after the last molt, in the Imported species. Before the last molt, indeed, the head is of a uniform black color, though it afterwards has a good deal of green in front; but the body remains throughout of the same immaculate green shade. It differs also in its habits from the Imported species, never, so far as we can find out, going underground to spin its cocoon, but always spinning that cocoon among the twigs and leaves of the bushes upon which it feeds.

"This species agrees with the other one in being double-brooded, the first brood of larvæ appearing about the end of June and the beginning of July, and the second brood from the middle of August to the forepart of September. But instead of the larvæ of the second brood lying underground in their cocoons all winter, they burst forth in the fly state from the beginning to the middle of September. Hence the female fly is compelled to lay her eggs upon the twigs instead of on the leaves; for if she laid them upon the leaves, as is the habit of the Imported species, the second laying of eggs, which has to pass the winter in that state, would fall to the ground along with the leaves in the autumn, and the young larvæ would starve when they hatched out next spring before they could find their appropriate food. Consequently, in the case of this species, we cannot apply the method of counterworking the other species which has been already referred to. For we have particularly remarked that the very young larvæ were not gathered in great numbers upon one particular leaf—as with the Imported species—but were distributed pretty evenly over the whole bush. Neither did they bore the singular holes through the leaf (Fig. 4), which render the other species so easy of detection when young.

"As will have been observed from the figures given above, the Native species, besides the differences already noticed, is only about two-thirds the size of the other in all its states. Like the other, it infests both currant and gooseberry bushes, but appears rather to prefer the Gooseberry. Indeed there can be little doubt that our native Gooseberries formed its original food-plant; for many years ago we captured a single specimen in the nighborhood of Rock Island, Illinois, in woods remote from houses, where the wild gooseberry was pretty abundant, and there was no wild red currant." The species was described in 1866 by Mr. Walsh, "from numerous specimens found stripping the gooseberry and currant bushes in Davenport, Iowa; and it has since been reported to us by Miss Marion Hobart, of Port Byron, N. Illinois, as so abundant in her neighborhood in 1868 on the gooseberries as to completely defoliate them three times over, so that she inferred—but we think erroneously—that there were three distinct broods of them, one generated by another. Mr. Jas. H. Parsons, of Franklin, N. Y., has in a letter to us expressed the same opinion with regard to the Imported species. Probably both parties have been deceived by what is a very common occurrence with many leaf-feeding larvæ. There is often a warm spell early in the year which causes a moiety of the eggs of a particular brood to hatch out. This is taken for the first brood. Then follows a long spell of cold weather, which prevents the other moiety of the same batch of eggs from hatching out till perhaps a month or six weeks afterwards.

When at last the moiety does hatch out, it is considered by inexperienced persons as a distinct second brood. There is also very frequently a great variation, probably from similar causes, in the time at which the same batch of pupæ burst forth into the perfect winged state. For example, out of a lot of 31 cocoons, of the second brood of the Imported Currant-worm Fly, all received by us at the same time from Dr. Wm. M. Smith of Manlius, N. Y., most of the flies came out between June 26th and July 11th, but a few did not appear till towards the latter end of July and one lingered on till August 13th."

As I have captured the female fly in East St. Louis, and as worms which, from the description, could not well belong to any other species, were noticed by Mr. T. W. Guy, of Sulphur Springs, on his gooseberry bushes in 1870, there can be little doubt that the species occurs with us, as it is generally distributed throughout the country. Mr. L. D. Votaw of Eureka, has also reported to me the occurrence on his place of a "small green and unspotted worm" on his currant bushes.

REMEDIES.

The same as for the preceeding species.

DESCRIPTIVE.

I reproduce, from the *Practical Entomologist* (Vol. I, p. 123), Mr. Walsh's original descriptions, drawn up from many specimens.

PRISTIPHORA GROSSULARIÆ—*Immature larva.*—Length not quite reaching ½ inch. Body pale green, with a rather darker dorsal line, and a lateral yellowish line above the spiracles, the space below which line is paler than the back. Anal plate and prolegs immaculate. Head black, not hairy. Legs brown, except the sutures.

The mature larva measures ½ inch in length, and differs in the head being pale green, with a lateral brown-black stripe commencing at the eye-spot, and more or less distinctly confluent with the other one on the top of the head, where it is also more or less confluent with a large central brown-black spot on the face. The legs are also green, with a small dark spot at the exterior base of each, and a similar spot or dot before the base of the front legs.

Imago—♀—Body shining black, with fine, rather sparse punctures. *Head* with the entire mouth, except the anterior edge of the labrum and the tip of the mandibles, dull luteous. Labrum transverse and very pilose. Clypeus short, squarely truncate, immaculate. Antennæ ⅔ as long as the body, joint 3 three and a half times as long as wide, joint 4 fully ¼ shorter than joint 3, 5—9 very slowly shorter and shorter; brown-black above, beneath dull luteous, except joints 1 and 2, which are black, tipped below with luteous. *Thorax* with the wing-scales honey-yellow and the cenchri whitish. *Abdomen* with the basal membrane whitish; ovipositor honey-yellow, its sheaths black. *Legs* honey-yellow, or sometimes pale luteous, with the six tarsal tips of the tibiæ and of the tarsal joints 1—4, pale dusky. *Wings* subhyaline, tinged with dusky; veins black; costa honey-yellow; stigma dusky, edged all round with honey-yellow, especially below. In a single wing of two females only out of forty-nine, the first submarginal cross-vein, which in this genus is normally absent, is quite distinct; and in a single wing of five other females, traces of it are visible on holding the wing up to the light. Length ♀ 0.17—0.21 inch. Front wing ♀ 0.19—0 23 inch. Expanse ♀ 0.41 —0.45 inch, (wings depressed.)

The ♂ differs from the female only as follows: 1st. The antennæ are a trifle longer, and as usual vertically more dilated, joint 3 being only 2½ (not 3½) times as long as wide. 2d. The coxæ, except their tips, and the basal half of the femora, are black; and in the hind legs the extreme tip of the tibiæ and all but the extreme base of the tarsus, are dusky. Anal forceps honey-yellow. Length ♂ 0.17—0.18 inch. Front wing ♂ 0.17—0.19 inch. Expanse ♂ 0 35—0.38 inch, (wings depressed.)

THE STRAWBERRY WORM—*Emphytus maculatus* Norton.

[Ord. HYMENOPTERA; Fam. TENTHREDINIDÆ.]

In connection with the foregoing account of the Imported and Native Currant Worms, it will be well to give the history and habits of a worm of the same family, which is the most conspicuous, if not the most common defoliator of that more profitable and more generally cultivated fruit—the Strawberry. This is the Strawberry Worm (*Emphytus maculatus* Norton) the natural history of which was first given by myself in the *Prairie Farmer* for May 25, 1867.

The species appears to have a wide range, as I have met with it in many parts of Illinois and our own State, have received it from Iowa, and it is reported from various sections in the East and from Ontario. In 1874, Prof. Bessey, of the Iowa Agricultural College, reported it as devouring the Strawberry plants in many parts of that State, and Mr. Hoffmeister, of Fort Madison, wrote me that in many sections the plants had to be plowed under in consequence of its devastations. Early in spring numerous flies, as shown in Fig. 10, *3* may be seen hanging to, and flying about the vines, in fields which have been previously infested. They are dull and inactive in the cool of the morning and evening, and at these hours are seldom noticed,

[Fig. 10.]

STRAWBERRY WORM: Ventral view of pupa; 2, side view of same; 3, enlarged sketch of perfect fly, the wings on one side detached; 4, larva crawling, natural size; 5, perfect fly, natural size; 6, larva at rest; 7, cocoon; 8, enlarged antenna, showing joints; 9, enlarged egg.

They are of a pitchy black color, with two rows of large, transverse, dull, whitish spots upon the abdomen. The female, with the saw-like instrument peculiar to the insects of this family, deposits her eggs by a most curious and interesting process, in the stems of the plants, clinging the while to the hairy substance by which these stems are covered. The eggs are white, opaque, and 0.03 of an inch long, and may be readily perceived upon splitting the stalk, though the outside orifice at which they were introduced is scarcely visible. They soon increase somewhat in bulk, causing a swelling of the stalk, and hatch in two weeks—more or less according to the temperature—and during the early part of May the worms attract attention by the innumerable small holes they make in the leaves. Their colors are dirty yellow and gray-green, and when not feeding, they rest on the under side of the leaf, curled up in a spiral manner, the tail occupying the center, and fall to the ground at the slightest disturbance. After changing their skin four times they become fully grown, when they measure about $\frac{3}{4}$ of an inch.

At this season they descend into the ground, and form a very weak cocoon of earth, the inside being made smooth by a sort of gum. In this they soon change to pupæ, from which are produced a second brood of flies by the end of June and beginning of July. Under the influence of July weather, the whole process of egg depositing, etc., is rapidly repeated, and the second brood of worms descend into the earth during the forepart of August, and from their cocoons, in which they remain in the caterpillar state through the Fall, Winter, and early Spring months, till the middle of April following, when they become pupæ and flies again, as related.

REMEDIES.

The same remedies recommended for the Currant Worms will apply here. They are more satisfactorily employed, however, and after the worms have been made to fall to the ground, a mixture of warm water and kerosene will destroy them as quickly as anything.

DESCRIPTIVE.

EMPHYTUS MACULATUS:—*Imago.*—Color piceous, with two rows of dull, dirty white, transverse spots upon the abdomen. Wings hyaline; veins black; eyes and eyelets black; antennæ black and 9-jointed. Legs brown and almost white at the joints. No particular difference of coloring in the sexes. Average expanse of female 0.53 inch; length, exclusive of antennæ 0.24 inch.

Larva—Length 0.60—0.65 inch when full grown, having changed but little in appearance from time of birth. Somewhat translucent. General color, pale, dirty yellow, with a glaucous shade along dorsal and sub-dorsal regions, inclining in most cases to deep blue green on the thoracic segments. Minutely wrinkled transversely. Venter light glaucous. Legs—6 pectoral, 14 abdominal, and 2 caudal—of the same color. Head of a more decided yellow than body, with usually a dark brown spot above, one nearly of the same size at the upper front, and two rather smaller ones at each side—joined by a brown line—the anterior spot being lower down than the other. In certain specimens these two are blended, and there is but a triangular spot on the top of the head, while the depth of shading on the body is also variable.

Pupa—Of a dingy, greenish-white color, the members being somewhat paler than the body.

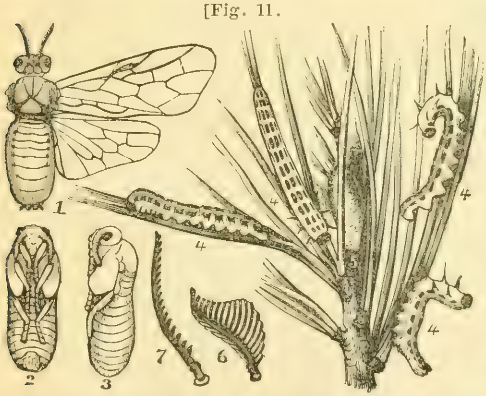
Numerous specimens in all states examined.

ABBOT'S WHITE PINE WORM—*Lophyrus Abbotii* Leach.

[Ord. HYMENOPTERA ; Fam. TENTHREDINIDÆ]

Belonging to the same Saw-fly family as the preceding species, are certain false-caterpillars which are very injurious to pines. They belong to the genus *Lophyrus*, so named from the plume-like antennæ of the males. In Germany whole forests of pine and fir trees have been destroyed by insects of this genus, and D. E. Miller has published a large volume on the depredations of four species which destroyed thousands of acres of pines in Franconia. Two species more particularly occur in the Mississippi Valley, and the one under consideration is the most injurious of the two. The habits and transformations of both were first partially made known by myself some ten years since (*Prairie Farmer*, Nov. 10, 1866, May 25, 1867, May 2, 1868, and P. F. Annual, 1869), and are more fully given herewith.

[Fig. 11.



ABBOTT'S PINE WORM: — Perfect fly magnified; the left wings removed; 2 and 3, enlarged pupæ; 4, larvæ in different positions, natural size; 5, cocoon natural size; 6, magnified antenna of male; 7, magnified antenna of female.

Abbot's White Pine Worm has been more frequently sent to me, with complaints of injury, from Indiana and Illinois. Yet it occurs over a wide extent of country, and in the columns of the *Rural New Yorker* and *American Agriculturist* frequent records of its injuries in the East are to be found of late years. While its injuries are reported from the northern part of Missouri, it seems not to occur in the southern part of the State.

The following passage from a letter received from Mr. Jos. T. Little, of Dixon, Ills., in 1869, gives a very good account of the working of the insect:

I find them on one clump of pines on my lawn, and in a small lot of pines in my nursery. Late last Fall, I discovered that those same trees had been attacked by some worm or other, and that the foliage had been stripped off the young shoots, which shoots dried up this Summer. We had a very hard freeze on the night of October 8th, the mercury being at 30 degrees above zero; but still the worms do not seem to be affected by the weather. They are very sluggish at any time in their movements. I have Scotch and Austrian Pine, Arbor Vitæ, Balsam Fir, Norway, Spruce and Red Cedar, in the immediate vicinity of the White Pines, but they are unmolested.

In 1872 Mr. A. W. Barber of Lancaster, Wis., lost some fine trees by its injuries, and it was complained of in many sections the past year. This worm, which is dingy white in color, with black head and black spots (Fig. 11, *444*) has, in every instance that has come to my knowledge done its principal injury late in the Fall, and may frequently be seen feeding into November, or after the ground is frozen about an inch deep. When full-fed, these larvæ enclose themselves in oval, bright bronze, or gold-colored cocoons, spun up between the needles, or in whatever sheltered situation is at hand. Sometimes the cocoon is formed upon the tree, but more often among the fallen needles and other debris and shelter beneath it. Within these cocoons the worm is very tightly packed, and remains till toward the following Spring, or even late Summer, when it becomes a pupa, with a dusky dorsal line and pale brown eyes (Fig. 11, *2*, *3*). The flies issue two weeks afterwards, and the sexes differ so much that they would be declared distinct insects by the uninitiated. The male, with the exception of the underside and tip of the abdomen, is jet black, his average length 0.23 inch, and the expanse of his wings, 0.47 inch. The female measures 0.30 inch, and expands 0.65 inch. She is of a honey-yellow, with the head and thorax somewhat darker than the abdomen; the thorax blackish at the upper posterior sides, and the abdomen having a lighter lateral stripe, with four or five blackish spots above it. These distinguishing features are much more striking in the living, than in the dried cabinet specimens. The antennæ in both sexes are black, those of the male 21-jointed and with 17 long and 17 shorter plume-like branches: those of the female serrated, with one or two joints less than the male, and 17 serrations.*

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*Fitch, in the brief and summary account given of *L. Abbotii*, says that the antennæ are 17-jointed; while another species, which he named *L. Lecontei*, and which he supposed was the parent of worms, the description of which answers perfectly to the above, he says, has 21-jointed antennæ. I have examined dozens of *L. Abbotii*, and the antennæ are usually 21-jointed in the ♂, and 19-jointed in the ♀, counting the scape or bulbus as 2, and the terminal enlargement as 2. In reality, however, the terminal joint frequently appears single, and the number of joints is found to vary in different individuals in the same species, when large material is examined. In *Abbotii* I have individuals with antennæ having 18, 19, 20 and 21 joints respectively; in *Abietis* the number varies from 21 to 23 in ♂, and from 14 to 18 in ♀, and in *LeContei* they are usually 21 in ♂ and 19 in ♀—always counting the scape as 2. *Abbotii* and *LeContei* cannot, therefore, be distinguished by the joints in their antennæ, as, with others, I myself once believed they could, and the relative number of antennal joints in this genus loses all specific value.

The eyes and eyelet are black, and the legs pale rufous in both sexes; while the wings are hyaline with prismatic colors. In escaping from the cocoon, the fly makes a clean, somewhat spiral cut at one end, always leaving a small hinge for its prison door to swing on.

These flies, in confinement, soon die without ovipositing, which indicates that they nourish on something out-doors. As with most saw-flies, the perfect insects are quite irregular in coming out of the ground, many of them issuing in May, but others not till toward the end of Summer. On opening cocoons that had passed the Winter I have found many yet containing the larva the latter part of June, while others of the same brood had become flies six weeks before. The species has generally been considered single-brooded; but as I have had the eggs laid as early as May, and the young worms feeding the latter part of that month, two broods are not improbably produced. In ovipositing, the female saws beneath the epidermis on one of the flat sides of the leaflet and pushes into the slit an egg, which is whitish, ovoid, 0.8 m.m. long on an average. As the egg swells it forms a conspicuous bulging of the epidermis, and the mouth of the slit opens and exposes more and more a portion of the egg. The young worm has the black head and black-ringed thoracic legs of the full grown individuals, but otherwise differs essentially from them, the body being uniformly pale and unspotted. The worms are more or less gregarious throughout their existence, and seldom leave a twig or branch till they have completely stripped it. Inconspicuous at first, they are seldom noticed till the denuded branches attract attention, and when, after the last molt, they strip a tree with astonishing rapidity. They have a habit of throwing back the head and tail when disturbed, and if violently shaken many of them will fall to the ground. They also use the tail end of the body to grasp more firmly the leaflets upon which they feed. This is the worm described by Fitch as the possible larva of *Lophyrus LeContei*, and the real larva of this last will be described further on.

NATURAL ENEMIES.

The reason that this Pine-worm abounds at times and then suddenly disappears, is that it is extensively preyed upon by a parasitic Ichneumon fly, belonging to the genus *Limneria*. The species, which I have also bred from some wax-feeding larva (probably *Ephestia zeæ*) does not fully accord with any of the descriptions of Norton, Cresson, or Provancher. I therefore briefly define it herewith:

LIMNERIA LOPHYRI, N. Sp.—♀, length 0.30—0.35 inch. Head and thorax black with silvery white pile. Antennæ piceous, more than half as long as body; but slightly paler toward tip; bulbus either yellowish or rufous. Ocelli either rufous or black. Mandibles, palpi, front and middle coxæ trochanters and tibiæ, pale yellow. Tegulæ almost white. Abdomen, with faint pile, rufous, the petiole and sides of next joint usually blackish. Hind legs rufous, the base of tibiæ and of tarsi paler.

♂ somewhat smaller, and with more black on the abdomen.

Four ♂'s, 12 ♀'s bred from larvæ of *Lophyrus Abbotii.*

REMEDIES.

As evergreens suffer more from defoliation than deciduous trees, it is essential, during the proper season, to scan them very closely every few days where this insect is known to prevail. When the worms are noticed, a syringing of hellebore water, or a dusting of fresh air-slacked lime, while the tree is bedewed, will destroy them. Care should be taken to prevent their injuries by clearing the ground around the trees late in the Fall, and burning the fallen needles and rubbish, with such cocoons as may be among them.

DESCRIPTIVE.

LOPHYRUS ABBOTII:—*Larva*—Average length 0.80 inch, though many will measure about an inch. A soft, dingy, white worm, having often a greenish or bluish line superiorly. On all joints but the first, which is entirely white, two oblong square black spots along the back, and another somewhat rounder spot each side. These become somewhat diffuse on the three latter joints, forming on the last a single black patch. Three black thoracic legs, fourteen abdominal, and two caudal prolegs. Thoracic joints largest; the three last, smallest and tapering. Some are marked very regularly, while in others the white space on the back between the spots on joints 5, 6, 7 and 8, is much wider than between the others. This is probably sexual difference, since those thus marked are shorter, thicker, and of a yellower white than those regularly marked. After each change of skin the head is at first white like the rest of the body, with the usual eye-spots black. No markings while young.

LE CONTE'S PINE WORM—*Lophyrus LeContei* Fitch.

[Ord. HYMENOPTERA; Fam. TENTHREDINIDÆ.]

Abbott's Pine Worm shows great preference for the White Pine and is seldom found on any other. It is, moreover, the most common and destructive species of the genus in our part of the country. LeConte's Pine Worm is, on the contrary, a more general feeder and prefers the coarse-leaved pines, such as the Austrian, Scotch and Pitch.

It is also most abundant in the East. It was first sent to me in October, 1867, by my friend A. S. Fuller, present editor of the *Rural New Yorker,* with the following letter.

I send you by to-day's mail a box of caterpillars found feeding on the Scotch and Austrian pines in my nursery. I can find nothing in Fitch or Harris which will enable me to identify them. These caterpillars have appeared in myriads in the last few weeks, and they do not pass a leaf, but take them all clean, old or young. If you can tell me all about this worm, please do so.

In a recent article (*R. N. Y.*, Nov. 25, 1876) referring to the injuries of what is evidently the same worm, though confounded with the preceding, Mr. Fuller writes :

We have already had some pretty hard frosts up to this date, Nov. 14, and yet a neighbor has just brought us some of these grubs taken from his pine trees. For several years past we have noticed that these Saw-fly larvæ remained upon the trees till very late in the Fall, and that it required a hard freeze to make them leave off feeding and descend to the earth, where they spin their cocoons among the old leaves and other vegetable matter.

These two pine worms have precisely similar habits, and, though bearing so close a resemblance to each other as to be easily confounded, LeConte's species is easily distinguished upon close examination by having the head reddish-brown, the spots differently shaped, and an extra row on each side. The female fly is distinguished by her black abdomen. For those interested the differences are presented more in detail in the following descriptions :

DESCRIPTIVE.

Lophyrus LeContei :—*Larva*—Average length, when full grown, about one inch. Color, dingy or yellowish-white, and void of any greenish or bluish hue. Dorsal black marks wider anteriorly than posteriorly, and usually broken transversely in the full grown individuals ; also further apart than in *L. Abbotii.* Lateral spots sub-quadrate, with an additional row of smaller black marks below them. Head shiny reddish-brown, with black eye-spot each side. Jaws tawny. Anal joint entirely black above. Venter and prolegs (14 abdominal and 2 anal) immaculate. Thoracic legs black, with white joints. When young it is without marks, and some of the full-grown specimens have them more distinct than others.

Pupa—Undistinguishable, except in the average larger size, from that of *L. Abbotii.*

Imago—The male fly can scarcely be distinguished at first sight from that of the other species, though the average size is somewhat greater, and the brown parts, viz.: venter, and tip of abdomen above, are of a somewhat deeper rufous-brown. The antennæ are more often and regularly 21-jointed than in *Abbotii.*

The female is distinguished, however, by her body being jet black above, except a small brown patch at the extremity and a transverse line of the same color just below the thorax ; and by her wings being smoky instead of hyaline. Venter with a black longitudinal line, more or less intense, each side. Thorax and head as in *Abbotii*, if anything, a little deeper in color. Average length 0.40, and expanse 0.70, though some will measure 0.50 inch and expand 0.82 inch.

There are several other American Saw-flies belonging to the same genus (*Lophyrus*) whose larvæ doubtless feed upon evergreens. One (*Lophyrus abietis* Harris) which is treated of by Harris, depredates more particularly on the Fir, and, as a worm, is at once distinguished by being green, with darker green lines, but no spots, and by making a grayer cocoon. The larvæ of *Lophyrus Americanus* Leach, *L. Fabricii* Leach, and of *L. compar* Leach are unknown, and I suspect that some of these supposed species will prove to be but varieties of the three whose habits are here recorded.

THE COLORADO POTATO-BEETLE.

In some parts of Iowa, Wisconsin and the Northwest, this insect was very troublesome again the past year, but from one cause and another, though principally on account of the wet character of the past two summers, it attracted little attention in Missouri and the larger part of the Mississippi Valley. Yet on the Atlantic, and especially in the New England States, it has been a most fruitful theme of discussion and a constant object of warfare: nor have its doings ceased to interest Europeans. A pretty full record of its movements and of the more important and practical topics connected with it, has been published by me from year to year, and quite a demand has been made for back copies of these Reports from people in the East, and even from Europe. The editions of the earlier Reports, which contained most information on the subject have long since been exhausted, and in order to satisfy the demand, I prepared last Fall a small work entitled "Potato Pests," in which, with other insect foes of the Potato, the Colorado Potato-beetle is treated of at length. The work is published by the Orange Judd Co., of New York, and what I have to say below is mostly taken from it, and will serve to complete and complement what has previously been published in these pages.

SPREAD OF THE INSECT DURING THE YEAR.

During the past year, 1876, the insect has swarmed in most of the New England States, and especially on the sea shore. It has extended north around Montreal, and was especially abundant as far as Trois Rivières;* while in its eastern progress it has overrun Con-

* L. Provancher in *Naturaliste Canadien*, Aug. 1876, p. 249.

necticut, Massachusetts, Vermont and New Hampshire and extended some distance into Maine. At Milestone and other places in Connecticut the beetles were washed ashore in such numbers in September as to poison the air, and the captain of a New London vessel found that they boarded him in such numbers while at sea that the hatches had to be closed. At many watering places, such as Cape May, Coney Island, Long Branch, Rockaway and Newport, they proved a great nuisance, being crushed and killed in large numbers by the continual promenading along the beach. The New York *Times* reported their impeding the progress of a train on the Central Railroad at Grinnell Station: "the rails were covered with them for a mile, and after a few revolutions of the drivers the wheels lost the friction and slipped as if oiled; *** they had to be swept off, and the track sanded before any progress was made."

The following items will further convey a good idea of the prevalence of the pest along the coast:

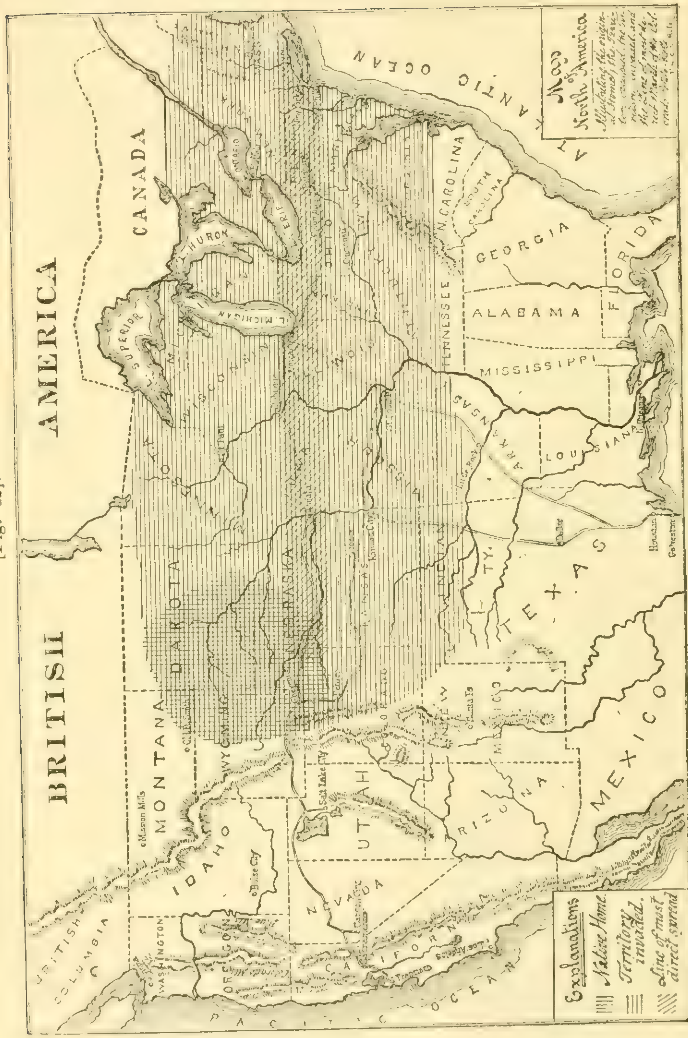
A day or two ago a party of gentlemen fishing near the middle of Long Island Sound, saw great quantities of potato bugs covering the surface of the water as far as the eye could reach. Every floating article, as well as the water, was packed with them, and many were clinging to eel-grass and sea-weed under the water. The wind was blowing from the south, and had probably carried them from the island, and they were being wafted toward the Connecticut shore. Inland on the island the bugs appear to be increasing in numbers, and, the potato vines being dry, they have attacked the egg-plants, pepper plants, and tomato vines.—[Correspondence of *N. Y. Tribune* from Huntington, L. I.

The sea coast in the vicinity of this city and the shores of Long Island Sound are, at the present time, undergoing invasion by countless myriads of potato bugs. Where the insects come from is a mystery. They seem to cling to the floating sea weed and are left therewith on shore by the tide. At Coney Island and other points directly on the ocean, the bugs are most numerous, showing that they have been brought hither by sea currents, and by similar means have been swept into Long Island Sound. It seems hardly possible that the insects will now fail to reach the other side of the Atlantic, as they may find transportation on vessels, or be carried over in the drifting weed of the Gulf Stream.—[*Scientific American*, Aug. 5, 1876.

While at Atlantic City, N. J., last Saturday, I noticed great numbers of the Colorado Potato-beetle flying about on the beach. I have never seen them so active before. Their unusual activity there may be the result of hunger, as there is an entire absence of the Solanaceæ, either wild or cultivated, in that vicinity.—[From a letter from G. W. Letterman, Allenton, Mo., July 22, 1876.

There were twice as many potato-beetles as all other kinds put together. They evidently had been eastward bound, dropped into the ocean, and were brought back by the returning waves. We may infer also that many never reached the shore again from which they had made their departure, but were gobbled up by the fishes that sometimes plentifully inhabit those waters. Nor is this all: some distance up the Bay, and nearer the town of "Lewes," there is a tressel work—called the "Pier"—which extends a quarter of a mile out into Delaware Bay, upon which is a railroad track, upon which the cars of the Junction Railroad daily run to discharge their cargoes into sailing vessels and steamboats that periodically leave the outer end of the pier for New York, Philadelphia, Boston, Baltimore and other points. In the morning and the evening, when less commercial activity reigns, the pier is esteemed a capital place to fish. Well, all along this pier, from the shore to the extreme outer end, the ubiquitous potato-beetle was present, and at the outer end far more numerous than nearer shore. The State of Delaware at the time was full of these beetles, from one end to the other. The fruit-growers were shipping their peaches to market, and every cargo brought down from the interior also brought down a goodly number of the beetles, and it is

[Fig. 12].



SPREAD OF COLORADO POTATO-BEETLE.

not at all surprising that they should be carried aboard of the waiting vessels, and transported to other parts of this country, if not to Europe.—[S. S. Rathvon, in *Lancaster Farmer*, Aug. 1876.

RATE AT WHICH IT TRAVELED.

Walsh estimated, from the rate at which it traveled in the earlier history of its march, that it would reach the Atlantic in 1881. From subsequent calculations I placed the date at 1878, but it in reality touched the Atlantic seaboard at many different places in 1874. It thus spread at an average annual rate of about 88 miles. But the annual rate was by no means uniform. Earlier in the history of its march the rate was much lower, and until it got east of the Mississippi, did not average fifty miles. A glance at the accompanying map (Fig. 12) will suffice to show that the line of most rapid spread was along the line of greatest human travel and traffic. In fact, after it had reached New York it began to extend and swarm both north and south along the coast, before many of the inland counties on similar parallels were reached by the main line of the immense army.

HOW IT TRAVELED.

As the larva is sluggish and never leaves the plant from which it is hatched, except in quest of more food, until it is ready to pupate, all the journeys of this insect are necessarily made in the perfect or beetle state by means of the ample rose-colored wings, which, when the insect is at rest, are compactly folded up beneath the striped wing-covers. Its spread, however, over the more populous portions of the country, is not to be attributed to its powers of flight alone. It undoubtedly availed itself, to no inconsiderable extent, of every means of transportation afforded to other travelers, and often got a lift on eastern bound trains, and most probably crossed the more barren plains bordering its native confines through man's direct agency, i. e. by being carried. There is a possibility that in some instances it may have been carried in the egg state on living plants, or in the pupa state in lumps of earth; but these modes of transit, if they have occurred at all, have necessarily been exceptional. Even the winds and waters aided its progress. Its invasion of Canada, for instance, took place at precisely the two points where we should expect to first meet with it in the Dominion, namely, near Point Edward, at the extreme south of Lake Huron, and opposite Detroit, near Windsor, at the southwestern corner of Lake St. Clair; for all such beetles as fly into either of the lakes from the Michigan side, would naturally be drifted to these points.

Many insects that are subject to very great multiplication, though not naturally migratory, often acquire the habit of migrating in swarms from one part of a country to another; and the migrating tendency has at times been quite marked in our Doryphora during its eastward march. This tendency is particularly noticeable in the last or Fall brood, and I have seen the beetles in autumn, swarming in the air or traveling in immense armies on foot—all instinctively taking the same direction, which is indeed a peculiarity of all animal migrations. There can be little doubt, therefore, that the larger areas have been traversed by this insect in the latter part of the growing season.

AREA INVADED BY IT.

From the foregoing account it is manifest that this pernicious beetle has spread over an area of nearly 1,500,000 square miles, or considerably more than one-third the area of the United States. It has traveled over two-thirds of the continent in a direct eastern line, and at least 1,500 miles of this distance since 1859. It occupies at the present time, more or less completely, the States of Colorado, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Kentucky, Ohio, New York, Pennsylvania, District of Columbia, Virginia and West Virginia, Maryland, Delaware, New Jersey, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and Maine, in none of which it was autochthonous, except the first mentioned. If we wish to outline the whole territory now occupied by it, we must add to the above, parts of Wyoming and Dakota, where it was native, a large portion of Canada and limited portions of N. Carolina, Tennessee, Arkansas, Indian Territory, Texas and New Mexico. The map given on page 36 (Fig. 12) tells the story better than any words I can employ.

CAUSES WHICH LIMIT ITS SPREAD.

There are reasons why the Colorado Potato-beetle did not spread as rapidly along the line of its southern as along that of its northern march. The first is, that the potato is not in such general cultivation along the latter as along the former parallel, and potato fields are, therefore, more scattered; the second, that the insect was northern rather than southern in its native habitat; the third, that it suffers and does not thrive where the thermometer ranges near 100° F. The larvæ frequently perish under such a broiling sun as we sometimes have at St. Louis, and during very hot, dry weather, it frequently fails, as it did in 1868, to successfully go through its transformations in the ground, which becomes so hot and baked that the pupa dries out, and the beetle, if it succeeds in throwing off the pupal skin, fails to make its way to the surface. For these reasons it may never extend its range very far south of the territory now occupied. Its northern spread is not limited by any such cause, and the intensity or length of the winter will hardly affect it, except in reducing the number of possible annual broods, and consequently its power of multiplication. The state of dormancy once entered into may continue a month or two, more or less, without seriously affecting most insects. We may expect, therefore, to see it push to the northernmost limit of the potato-growing portion of the country—a limit which it has already well nigh reached.

The question whether it will extend farther westward and reach the Pacific, is a more interesting one. There is the best reason for believing that the Rocky Mountains furnish an impassable barrier to it, as they do to so many other insects. It has already been shown (Rep. 7, p. 2) how potatoes in the mountains were for years less affected than were those of the Mississippi Valley; but that in 1874 the insect proved quite injurious to those of the mountain region of Colorado. The fact is well established that it has not reached more than three or four miles into the mountains, or to about the middle elevations—say 8,000 feet above the sea level. The reason is that the atmosphere above that level is so dry and attenuated that, taken in connection with the cool nights, the eggs, or the larvæ that succeed in hatching from them, shrivel and dry up. We have here, therefore, a physical barrier to its further westward progress, and the beetle is no more likely to reach California without man's direct assistance and carriage than it is to cross the Atlantic Ocean without the same means. Whether it could thrive on the Pacific Coast, where the summers are so dry, is another question; but I fear it would hold its own, in many portions, if once introduced. In this connection it will be well to state that geographical races of *Doryphora 10-lineata*, differing in no very important characters from the typical northern specimens, occur in S. Texas, New Mexico, Arizona and Mexico, though they seem to have no more acquired the potato-feeding habit than the *D. juncta* has done.

HOW IT HAS AFFECTED THE PRICE OF POTATOES.

During the earlier years of the insect's devastations in the Mississippi Valley, it materially affected the price of potatoes, not only by its direct ravages, but by discouraging farmers from attempting to cultivate the crop on an extensive scale. In 1873 the price reached the high figure of $2.00 per bushel (wholesale) in the St. Louis market, and many a family had to forego the luxury of a product which a few years before had been one of the cheapest of the farm, and so abundant as to enter largely into the feed of all kinds of stock. At the present time, with the improved methods of fighting the enemy, there is no longer the same dread of it in the Western States that formerly existed: its management is considered part of potato-culture, and its natural enemies assist man to that degree that its effect on the crop is less felt. The quality of the tuber was very seriously affected through the defoliation which the vines so generally endured, and it was at one time difficult to get a non-watery potato on our western boards.

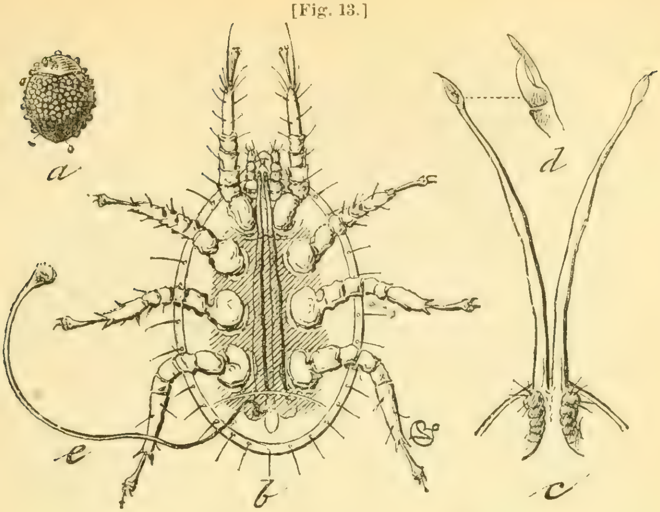
THE MODIFICATION IT HAS UNDERGONE.

In previous Reports I have, from year to year, shown how the species, as it spread over the country, became modified in habit, and increased the number of its food-plants. It has also undergone considerable modification in character. Specimens which I have examined from different parts of the country, show great variation in the marks of the thorax, in size, in coloration, and even in the ornamentation of the elytra and legs. The yellow varies from deep gamboge to almost pure white, the black line along the elytral suture is either very distinct or as obsolete as in *juncta;* while some specimens have the pale legs and the femoral spot, more or less distinct, which are so characteristic of this last. In northern Iowa and Wisconsin I have seen millions traveling over the ground, the average size of the individuals being not more than half that of the more typical specimens; and the general ground-color being white rather than yellow. In its southern range the colors tend to brighten and the black to become more metallic. Indeed, the variation which it has already exhibited furnishes interesting material for the close species makers.

AN ADDITION TO ITS NATURAL ENEMIES.

Among the many different enemies of this potato depredator that I have treated of, only one true parasite (*Lydella doryphoræ*) was, up to 1876, described, and that an internal one. In the summer of 1873, Mr. H. C. Beardslee, of Paynesville, Ohio, sent me a mite with which he found Doryphora attacked, and last summer this same mite was found by Mr. W. R. Gerard, to very generally infest the beetles around Poughkeepsie, N. Y. It sometimes so thickly crowds and covers its victim that no part of this last is exposed, and the beetle thus infested languishes and eventually perishes. This minute parasite is about the size of the head of a small pin, broadly oval, depressed, the body in one piece, somewhat tough above, and yellowish-brown in color. It is not uncommon on other beetles, and is closely allied to a well known European mite parasite of beetles and other Articulates—the *Uropoda vegetans*. This last is described by authors as possessing the peculiarity of attaching itself to the hard, shelly parts of its victims by means of a thread-like filament that issues from the posterior part of the body. A careful study of our American

[Fig. 13.]



UROPODA AMERICANA:—*a*, Colorado Potato-beetle attacked by it—nat. size; *b*, the mite, ventral view, and showing the penetrating organs lying between the legs; *c*, the organs extended; *d* the claw; *e*, the excrementitious filament—all greatly enlarged.

species has convinced me that the similar anal filament, which also helps it to adhere to Doryphora, is in reality excrementitious, sticking to the beetle and to the mite by a flattened disc at either end—being quite fragile and easily broken. The true penetrating organs, which enable the mite to hold tenaciously to its victim, and doubtless assist in obtaining nourishment, I have discovered to be a pair of extensile processes, each armed at the tip with a bifid claw, somewhat resembling that of a lobster. When at rest these organs are retracted and lie between the legs and just under the skin. When extended, they are usually brought closely together and extend the whole length of the animal beyond the head. They seem to be thrust forward by a series of muscles at the base, and I have frequently seen one extended while the other remained retracted. Thus, in addition to the more frail excrementitious and adhesive filament, this *Uropoda* is provided with an organ that is beautifully adapted to penetrating the hard covering of beetles, and of thus securing it to its slippery support.*

* As will be seen by the figure, these organs in repose extend so far back toward the anus that it is difficult to believe that they compose part of the mouth structure. Yet in carefully studying them I felt convinced that they were maxillæ, or rather the homologues of these organs in hexapods, and, in June, 1876, so informed Dr. A. S. Packard, Jr., to whom I submitted specimens Through his courtesy I have recently (Jan. 5, 1877,) had the pleasure of perusing an elaborate and admirable article by P. Kramer, of Schleusingen, Prussia, on the natural history of certain genera in the family Gamasidæ, published in the *Archiv fuer Naturgeschichte*, 42d year, Part I, 1876. According to Kramer these hitherto undescribed organs (his *Scheerentaster*) occur in most Gamasid mites, though differing greatly in length and considerably in form in different species He considers them 3-jointed, the basal joint simply cylindrical, the second likewise so at base, but ending in a strongly chitinized claw, generally toothed inside, and the third forming the inside finger of the claw, also generally toothed. In *Uropoda Americana* no true joints are discernible in the body of the processes, though there are restrictions. These maxillæ are evidently elastic and the anterior portion may be retracted more or less into the basal. Nor should I designate as a joint the thumb-like articulation of the terminal claw. Indeed, these claws seem to me to both of them articulate on the end of the process. In the species under consideration two teeth aro sometimes discerned on the small thumb, but ordinarily they are not easily resolved.

ITS INTRODUCTION TO EUROPE.

While some Europeans have been unduly alarmed, and inclined to take proscriptive measures to prevent the insect's introduction, others have ridiculed the idea that the insect could get to Europe, one of them declaring that there is no more danger of the insect's chance transportation than that of our rattlesnake.

The opinion is also freely expressed by certain good authorities, that the female could not retain her eggs during a whole passage. They forget that the eggs are laid at different times, covering a period of several weeks, and that the hibernating beetles are restless and active, without inclination to lay, for several weeks in Fall and Spring.

The actual occurrence of a living beetle on the Bremen Dock Yards, in a cargo from New York, was extensively reported in the press last Summer, but as the accuracy of the report was subsequently questioned, I took some pains to ascertain the truth. The German Consul at New York, H. A. Schumacher, obtained for me every assurance of the fact; while Prof. Dr. Buchenau, of Bremen, confirms it. The beetle was found alive in unloading a cargo of Indian corn from the steamer "Neckar," and another specimen was found in mid-ocean on the coat of a passenger of the same vessel.

Others, and among them some good entomologists, particularly of the Belgian Entomological Society, continue to express the belief that our Doryphora would not thrive if introduced. I have already expressed my belief that "an insect which has spread from the high table lands of the Rocky Mountains across the Mississippi Valley to the Atlantic, and that flourishes alike in the States of Minnesota, Wisconsin, Upper Canada and Maine, and in Maryland, Virginia and Texas—in fact, wherever the potato succeeds—will not likely be discomfited in the potato-growing districts of Europe."—7th Rep., p. 5.

The more serious and weighty reasons against the possibility of acclimatization, have been urged by H. W. Bates, F. L. S., in a memoir published in 1875, in the Journal of the Royal Agricultural Society of England, (Vol. XI, Part II). He argues, firstly, that no American beetle has been acclimated in Europe, though several European species are known to have been in America; secondly, that the group to which Doryphora belongs is not represented in Europe, and is remarkably restricted to elevated plateaux in the interior of this continent, and range toward the tropics rather than toward the north; thirdly, that the insect has not passed west of the dividing ridge of the Rocky Mountains, or got foothold on the Pacific Coast, which in climate more nearly resembles Western Europe.

Mr. Bates lays some stress on the fact that few American plants and insects have been acclimated in Europe, citing only the Common Water Weed, (*Anacharis Canadensis*), which has spread through their ponds and canals, and the Grape Phylloxera, which has done so much injury to French vineyards. He also says that no American beetle has become acclimated. While it is true that we have received many more species than we have given, enough more of our insects and plants have established themselves there to weaken the force ot the objection. The Horse Weed, (*Erigeron Canadense*), and the Grape Mildew, (*Oidium Tuckeri*), may be added to the plants; our common White Ant, (*Termes flavipes*), has done much damage in some parts of Germany; the Woolly Aphis, or American Blight, (*Eriosoma pyri*), is quite a pest in England and on the Continent; a minute yellow ant, (*Myrmica molesta*), which so annoys our housekeepers, has, according to Fr. Smith, been naturalized, and is very troublesome in England; while at least two of our beetles, viz., the Pea Weevil, (*Bruchus pisi*), and the American Meal Worm, (*Tenebrio obscurus*), have been naturalized in Europe—the former doing some damage in S. France; the latter being quite widespread and now sent back in about equal numbers with the European Meal Worm, (*Tenebrio molitor*), by those who make a business of rearing the worms for bird fanciers.

There is some force in all of his arguments, but Mr. Bates does not sufficiently appreciate the exceptional adaptive and migrating powers which the species has exhibited. There are hundreds of North American insects—and some of the most injurious too—which no one fears will ever reach Europe or establish themselves there, because they are restricted, and have for years been restricted to certain geographical areas. They have exhibited no especial powers of adaptation to new conditions. But our Potato-beetle forms one of those exceptional cases that occasionally confront us. We mark and note the exceptional vitality though we cannot give a reason for it. Why has *Doryphora 10-lineata* overrun the country and become such a pest, while its scarcely distinguishable congener, *Doryphora juncta*, feeding on the same genus of plants, has proved incapable of that adaptation, and remained harmless? Whatever the reason, the fact weakens the force of all generalizations based on geographical distribution. The reasons why the species has not passed west of the Rocky Mountains, find also their best explanation in the facts already mentioned in considering the causes which limit its spread.

The possibility of its importation, in a living condition, on vessels, is now assured by the experience of the year 1876, and I must think, with the facts before me, that the possibility of its acclimatization is equally great, especially in South Europe. That it would also hold its own in England and Ireland I have not much doubt. It will rather enjoy the more temperate climate; for while it thrives best during comparatively dry seasons, both excessive heat and drouth, as well as excessive wet, are prejudicial to it. Let us hope that it never will become established in Europe, but that a sufficient knowledge of it will be disseminated there to cause the speedy detection and extermination of the few that may, from time to time, be carried over. Let the Europeans not neglect precautionary watchfulness, however, by virtue of the arguments of those who believe that the insect could not stand their climate—lest they some day learn to their sorrow that they have needlessly underrated our Doryphora's toughness of constitution.

It is gratifying to note that some of the governments are not neglecting those precautions. The Commissioners of Customs in Great Britain have issued an order, accompanied by a description and figure of the insect, directing the officers of the Out-Door Department of the Service to especially look for and destroy any beetle answering the description given, which they may find "on board vessels, or on wharves, quays, sheds, or packages landed from vessels," and to encourage other persons to do the same.

The German Government has also issued a fine colored placard, to be posted on ships communicating between the two countries. Surrounding well executed figures of the insect in different stages, occur the following appeal and directions, the whole gotten up very much as recommended in my 6th Report.

LOOK OUT FOR THE POTATO-BEETLE!

A warning and request, addressed to all who can assist in preventing the importation of this beetle, and thereby make themselves Benefactors of their Fatherland.

Published by Order of the Royal Prussian Agricultural Department.

The drawing herewith presented shows the insect, with eggs and larvæ, which is known in North America as the Potato-beetle, Colorado Potato-beetle, Colorado bug and Potato-bug; and which, of late years, has damaged the potato to such an extent as to render its cultivation, in some parts of America, almost impossible. Therefore the importation of this beetle into Germany should be prevented by all possible means. The Potato-beetle and its larvæ live principally on the leaves of the potato plant; but it has also been known to feed on the different species of night-shade, on the tomato, and even on cabbages.

[Here follows a succinct and very good account of its natural history, and of its spread over the continent.]

The only danger of importation of these insects into Germany lies in the maritime intercourse between the two countries. Swarms of the beetles are carried out to sea by the wind, and it is not improbable that numbers of them might fall onto ships, and so reach, alive, the German sea-ports, it being proved by experiment that they can exist for six weeks without food whatever. It is also possible that they might be brought on ship-board singly through being packed in with vegetables purchased in American sea-ports, such as cabbages or tomatoes, or other merchandise. Larvæ and eggs might be shipped in like manner. [This, as I have already shown, is unlikely.] In the earth adhering to the potatoes there is also danger, as with it the pupæ and even the beetles can be imported.

Now, as all remedies hitherto tried against this pest, such as hand-picking or poisoning in the fields, have proved unsatisfactory [it is scarcely necessary to state to the American reader that this is incorrect], the importation of the beetle into this country would be simply the destruction of German potato culture, on which, in a great measure, depends the subsistence of our population.

All captains, crews and passengers on vessels running between America and Germany will, we hope, willingly lend their assistance to the prevention of such a calamity by keeping a sharp look-out for beetles, eggs, larvæ and pupæ; by destroying every specimen found on ship-board; by avoiding all unnecessary trade in vegetables; by using all possible precaution in the matter of clearing ships, etc.—thus materially helping the officers of our sea-ports.

All officers of German sea-ports are requested to inspect keenly all articles of American export whereby the beetle might be unintentionally introduced into Germany. The importation of potatoes from America, and the transferring of potato peelings and kitchen waste from the ships to land, is herewith forbidden.

"POTATO PEST POISON."

Several persons wrote last Summer to get my opinion of a purported new remedy for the Colorado Potato-beetle, then being extensively advertised under the above name by the Kearney Chemical Works, 66 Cortland street, New York City. I should, on general principles, dissuade any one from purchasing a secret remedy, when a cheap, simple and effective one is well known. Yet, as there is always room for improvement, and the inventor and discoverer of something valuable has a right to profit by his discovery if he can, I am just as ready to commend as to condemn any insect remedy offered to the public, according as it merits condemnation or approval—desiring to do justice to the rights of the individual as well as of the public. What, then, is this *new* "Pest Poison," and does it represent some valuable discovery which deserves to be kept a trade secret? Or is it simply one of the many secret nostrums constantly offered to the farmer by schemers who desire to fill their own pockets? Let a candid consideration of the matter decide.

The circular of the firm claims that this "pest poison" is manufactured on "strictly scientific principles," and that it is "the only safe, sure and cheap destroyer of potato and tomato bugs, chinch bugs, cut worms, wire worms and army worms, caterpillars, and all insects which prey upon vegetation!" Whenever men are found making the ridiculous claim, for any substance whatever, that it is a universal cure for all noxious insects, it is safe to set them down as ignoramuses or charlatans. The habits and modes of life of insects are so varied that what may prove a perfectly satisfactory remedy against one species is often utterly worthless against another; while for successful warfare special tactics are required in almost every case. The circular further unqualifiedly claims on one page that the poison "is not injurious to vegetation," while admitting in a special notice on another page "that, if used too strong or too frequently, it injures vegetation." The truth is that many tender plants are injured by it even when used as recommended, while even stout leaved evergreens are seriously injured when the strength of the solution is doubled. In the "directions for use" we find brief accounts of various insects, which show on their face that the authors of the circular and agents for the poison know nothing about the insects they speak of, and recommend their poison for species upon which it has never been tried. The directions under the head "Army Worm" may be taken as a sample. The passage, with the exception of the first and last sentences, is taken almost word for word, without credit, from an article of mine (New York *Tribune*, November 16, 1875); and in the sentences excepted, we are told that the army worm belongs to the "order of *noctua!*" (*Noctua* is an old genus of the order *Lepidoptera*), and that for this insect the solution must be made of double strength, whereas, thus made, it will injure most grasses.

The special notice closes with the following paragraph:

> Furthermore, lest a prejudice should be founded on the fears of some people that the vines or crops will absorb the poison, we have before us detailed experiments for several years past showing that not a trace of this poison has ever been found in potatoes or grain which have been watered with this solution in much greater quantities than was necessary to destroy worms or insects, and the opinion, also, of eminent chemists, that once in the ground the poison is completely neutralized.

Here again the circular misleads, and I very much doubt whether there is a particle of truth in the statement as to the years of experience or the opinions of eminent chemists. Such language would hold true of the Paris green mixture, but not of the poison advertised. This, upon analysis, proves to be a mixture of arsenate of sodium and common salt, faintly colored with rosaniline; and as opposed to the opinions of the unnamed "eminent chemists" of the circular, I will quote the opinion of Professor Wm. K. Kedzie, of the Kansas State Agricultural College, who says that "the great objection to the use of these compounds is their extreme solubility in water. They are offered to the plant in perfect condition for absorption into its circulation; and while, in the case of Paris green, the minute proportion dissolved is at once rendered inert by the hydrated oxide of iron in the soil, it is by no means certain that the proportion of the latter is in every case sufficient to accomplish this when the arsenic compound is applied in such large quantity and in complete solution."

Last year, in my eighth Report, I had something to say of a "Potato Pest Poison," manufactured by the Lodi Chemical Works of Lodi, N. J., showing that it did not work as effectually as the Paris green mixture, and that there could be no advantage to the farmer in its employment. It was composed of equal parts of salt and arsenic (arseniate of soda). Experiments which I made last Summer show that the Kearney pest poison acts very much like its Lodi prototype, the only advantage over which it can claim being the faint coloring. The Lodi Company sold a 1 lb. package for $1, which was to be dissolved in 120 gallons of water or more. The Kearney Company sell a half pound package for 50 cents, which is to be dissolved in 60 gallons. Of course either company could get any number of testimonials as to the efficiency of their compounds. They herewith have mine. To put forth the false claim of the circular I have noticed, is simple humbug. There are plenty of farmers, who, rather than go to the trouble of making their own mixtures, will send for such poison packages, when they once know what the mixture is, where they would not think of ordering a secret remedy. My advice to the manufacturers would be "do not sail under false colors, or claim more than your mixture deserves: let people know that there is just as much danger, if not more, in its use, as there is in the use of Paris green in the wet method. Do this, and put your article up in more secure packages, so that the poison in deliquescing does not soak and drip through in hot weather as it now does; and I believe you will still do a good business, and deserve *not* to be ranked as charlatans."

THE ARMY WORM—*Leucania unipuncta* Haw.

FURTHER NOTES AND EXPERIMENTS THEREON.

In the article on this insect in my last Report, certain important and mooted questions as to the mode, place and time of oviposition were settled definitely by observation. I have made further observations and experiments during the past year which are of interest as completing our knowledge of this insect's natural history. They were summed up in a brief paper read before the American Association for the Advancement of Science at its meeting in Buffalo, and what follows is mainly taken therefrom.

The eggs are thrust in between the sheath and stalk of well grown grasses, whether cut or standing; or occasionally in between the natural fold of the green leaf or the unnatural curl at the sides of a withered leaf. On low blue grass, where my first observations were made, they are, as stated last year, almost invariably laid in the fold at the base and junction of the terminal leaf with the stalk. The moth invariably endeavors to secrete them. They are generally laid in single rows of from five to twenty and upward, and they are accompanied with a white, glistening, viscid fluid, which glues them to each other and to the plant, and, when laid in the fold of a spear, draws the two sides securely over them, leaving but a glistening streak along the more or less perfectly closed edges.

There is one other mooted question in the natural history of the Army Worm which I have, the past Summer, been able to settle, viz. whether the species is single or double-brooded. In the review of the matter in my 8th Report, I came to the conclusion that, in the more northern States at least, or over the larger portion of the country in which it proves injurious, it is but single-brooded; and I am still of the opinion that such is the case. But I have proved that, like so many other species which are single-brooded further north, it is frequently, if not always, double-brooded in the latitude of St. Louis. By carefully feeding the moths reared from my first larvæ with sweetened water, and supplying them with grass in spacious vivaria, I succeeded in obtaining eggs from them. These eggs in due time hatched, and the second brood of worms gave me the moths again early in August. The worms were generally paler than those of the first brood, and being the second generation reared in confinement, they were less healthy. I obtained, in consequence, but five moths, all of them unfortunately females. One of these escaped, three died without showing any development of the ovaries, while the fifth died with the ovaries so well developed that the eggs, in a state of nature, would probably have been laid within a week. This was about two weeks after issuing or about the middle of August, and would indicate that a third generation of worms may exceptionally be produced. Indeed, by dilligent search out-doors I found larvæ of different sizes all through the month of August, and a few full grown individuals as late as the 23d of September. Moths were also obtained as late as October 9th from such worms. There is the greatest irregularity about the development of individuals of the same brood and little doubt in my own mind that while the production of a third generation of worms is the exception it may some years prove the rule.

The male moths, reared and fed in confinement, lived on an average 10 days; the females which were impregnated, twice as long, commencing to lay about a fortnight after issuing. What I have previously said as to the longevity of these moths applies therefore to the last or Fall brood only. The worms obtained the latter part of September entered the ground and were found dead upon subsequent examination, but would doubtless have hibernated in chrysalis and confirmed the conclusions which I have drawn (Rep. 8, p. 45) that the species may hibernate in the chrysalis as well as the moth state.

All the observations I have made are in harmony with the practical conclusion arrived at a year ago, that the eggs of this insect do not, as a rule, if at all, pass the Winter at the foot of grass stalks, as was heretofore surmised. Nevertheless, the burning over of meadows and grain stubble in Winter will act as a preventive of Army Worm injuries, for the reasons that the moth lays very early in Spring, that she prefers the full-grown sheath and stalk, even when dry, to the young green spears, and that she cannot well lay her eggs, for want of support, where the grass is yet sparse and thin, as it is when first starting in a burned meadow. In my last Summer's experiments the females, in secreting their eggs, invariably showed a preference for old hay over fresh and growing grass. Finally, without entering into further details, I give the following as a revised summary of the history of the Army Worm:

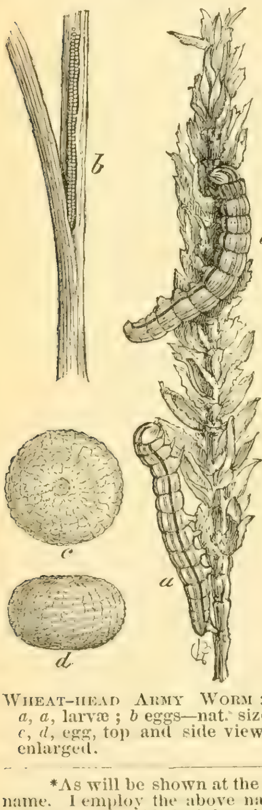
SUMMARY OF ITS NATURAL HISTORY.

The insect is with us every year. In ordinary seasons, when it is not excessively numerous, it is seldom noticed: 1st, because the moths are low, swift flyers, and nocturnal in habit; 2nd, because the worms, when young, have protective coloring, and, when mature, hide during the day at the base of meadows. In years of great abundance the worms are generally unnoticed during early life, and attract attention only when, from crowding too much on each other, or from having exhausted the food supply in the fields in which they hatched, they are forced, from necessity, to migrate to fresh pastures in great bodies. The earliest attain full growth and commence to travel in armies, to devastate our fields, and to attract attention, about the time that winter wheat is in the milk—this period being two months later in Maine than in Southern Missouri; and they soon afterwards descend into the ground, and thus suddenly disappear, to issue again two or three weeks later as moths. In the latitude of St. Louis the bulk of these moths lay eggs, from which are produced a second generation of worms, which become moths again late in July or early in August. Exceptionally a third generation of worms may be produced from these. Further north there is but one generation annually. The moths hibernate, and oviposit soon after vegetation starts in Spring. The chrysalides may also hibernate, and probably do so to a large extent in the more northern States. The eggs are inserted between the sheath and stalk, or secreted in the folds of a blade; and mature and perennial grasses are preferred for this purpose. The worms abound in wet springs preceded by one or more very dry years. They are preyed upon by numerous enemies, which so effectually check their increase, whenever they unusually abound, that the second brood, when it occurs, is seldom noticed; and two great Army Worm years have never followed each other, and are not likely to do so. They may be prevented from invading a field by judicious ditching; and the burning over of a field, in Winter or early Spring, effectually prevents their hatching in such field.

THE WHEAT-HEAD ARMY WORM.—*Leucania albilinea** Guen.

There can be no more tangible evidence, in present time, of the truth of evolution, and of the constant modification in habit, and consectaneous modification in structural and colorational characteristics among animals, especially among the lower classes, than the frequent appearance, as destroyers of our crops, of insects that were never reported as injurious before. When entomologists speak of a new insect enemy, they are not to be understood as implying a new creation. In a great majority of instances the species has long before been known to them, and has simply, for one reason and another, become unduly multiplied so as to force itself upon the attention of the common observer. In other cases it is new only to a particular locality to which, from some other region, it has been introduced. Yet in the most restricted and well worked-up localities, speaking either zoölogically or botanically, new forms appear, and old forms sometimes disappear, in a manner which can scarcely be explained, except by the extinction of the one and birth of the other through modification. Few naturalists at this day doubt that new forms have thus originated in the past.

[Fig. 14.]



WHEAT-HEAD ARMY WORM:—*a*, *a*, larvæ; *b* eggs—nat. size; *c*, *d*, egg, top and side view—enlarged.

*As will be shown at the close of this article, this insect is quite variable and has received another name. I employ the above name simply because it is appropriate and because the insect fully agrees with Guenée's published description. To say *albilinea* Huebn, carries no such definite idea, and *Harveyi* Grote is, in my opinion, but a variety. There is and always must be doubt as to what *albilinea* Huebn. virtually is, since it is founded mainly on a figure; and where there is such indecision it is, in my judgment, and in that of many others, best to discard Hubner. It is for this reason that I consider Guenée's description original, as applying to the species under consideration, and that his name should not be superceded by any other under which the insect may have been subsequently defined.

They are thus originating at the present, and we may occasionally get a glance at the process by the phenomena just referred to.

In the Summer of 1874, reports were not unfrequent of injury to wheat and timothy heads in Maryland and Pennsylvania by a worm which, by rearing, proved to be *Leucania albilinea* Guen.

In June and July of 1875, complaints were again heard, particularly in the two States mentioned, of a worm that injures the heads of the small grains while in the milk. The *Baltimore American* (see *We'kly N. Y. Tribune*, July 13, 1875,) describes it as hollowing out the soft grains, and leaving nothing but the shell and the chaff, and says that "in some rye fields the heads are almost void of grains, and the ground literally covered with chaff," and that "late sowed rye would not be worth the harvesting were it not for the straw." A correspondent from York, Penn., (July 15, 1875,) describes it as playing sad havoc with the wheat-heads here. Wm. T. Smedley, of Lionville, Chester county, and S. S. Rathvon, of Lancaster, Lancaster county, Penn., sent me specimens in 1875, with accounts of their attacking timothy seed and wheat while yet soft. The complaints were more numerous in 1875 than in 1874, though still confined to the Eastern States.

In 1876 this worm suddenly made its appearance in Kansas, especially in Dickinson, Douglas and Davies counties. The first specimens I received were accompanied by the following letter from Mr. Jno. W. Robson, of Cheever, Dickinson county, and dated June 14, 1876:

I inclose a number of catterpillars which are devastating the wheat fields of this county and causing considerable alarm. It was first noticed about ten days ago on Holland Creek, south of the Smoky Hill River, and along the east line of the county north of the same river. Yesterday I discovered it in our wheat. I live close to the north line of the county. This insect is quite new to me, but I judge it belongs to the order Lepidoptera, and strange to say, though a pretty close observer of insect life, I have not noticed any unusual quantity of moths or butterfl es hovering over the wheat. The catterpillars begin their depredations at the base of the ear, and sometimes near the center of the ear. In one field that I examined to-day, the catterpillars were abundant. They were mostly at rest, reclining at full length upon the straw, while only a few were feeding on the ears. Any information will be thankfully received. Farmers calculate that they will lose one-third of their crop.

In addition to the specimens received from Mr. Robson, others were sent to me about the same time from different parts of Dickinson, Douglas and Davies counties in that State. The *Salina* (Kansas) *Herald* refers to the ravages of this same worm in that neighborhood, and the *Kansas Farmer* of June 28, publishes several items which indicate that the pest created no little excitement. As grain began to ripen in the East, the worm again attracted attention there, and specimens were received from Mr. G. W. Shaw, with an account of their ravages along the old Reading Railroad, in the immediate vicinity of Philadelphia. The insect is also alluded to in the *Country Gentleman* for July 15, as doing injury in York Co., Penn.

Now the interesting feature about this insect is that its appearance in such destructive numbers and its habit of attacking wheat heads are modern phenomena. None of the early writers on economic entomology in this country refer to anything of the kind, and the first notice that I recollect seeing of this habit in this insect was in the Summer of 1872, when, in the N. Y. *Tribune*, Mr. R. W. Hudson of Huntington county, Penn., described a worm which seriously injured his and a neighbor's oats fields by destroying the heads, and which was erroneously supposed to be the Army Worm. It is highly improbable that the conspicuous ravages of a worm of this kind could have gone unnoticed and unrecorded, either by farmers or entomologists, if they had occurred; and the fact that the species shows a large degree of variation, warrants the belief that it has been lately modified. Feeding originally on some wild grass; undergoing modification, and first acquiring the peculiar habit here described in York county, Pennsylvania, this wheat-head-feeding race may subsequently have been carried to Kansas either in the chrysalis or moth state, or, what is more likely, in the egg state on grain and grass. This would account for its attracting attention there before it was noticed in the intermediate country. Yet a dark form occurs in the intermediate country, because I reared such a dark form, answering to Hübner's figure, in 1870, from larvæ that had transformed in a rye field at Kirkwood, Missouri. The wheat-feeding race may be expected to widen the area of its devastation until it spreads over the larger part of the country, and, like its long and well known congener, the true Army Worm, becomes unusually abundant and injurious, whenever the conditions are favorable to its multiplication. We may also expect an increasing tendency in the species to vary, and give rise to still other varieties and races that will perplex definers and describers.

[Fig. 15.]

MOTH OF WHEAT-HEAD ARMY WORM.

HABITS AND NATURAL HISTORY.

As I have abundantly proved, by rearing one generation from the other, this insect is double-brooded with us.* The first moths appear

* It is quite probable, however, that, as with the true Army Worm—which, as we have just seen, is double-brooded further north—this, its congener, produces but one brood annually in the higher latitudes, the insects hibernating mostly in the perfect state. Indeed, there would seem to be such irregularity in this regard that both peculiarities may occur in the same locality; for of a number of chrysalides collected at Lionville, Pa., in August, by Mr. Smedley, from among the shatterings that fell from the mow when threshing wheat that had been harvested early in July, a few only gave out the moths, and the rest are hibernating. Moreover, it would seem that where one brood only is produced, the moths partake of the intermediate characters between the summer brood, which has the pale secondaries and accords so fully with Guenée's description, and the spring brood with darker secondaries, which accords with Grote's *Harveyi;* for specimens bred by Mr. Lintner, of Albany, New York, in August, have, in both sexes, the intermediate size and the secondaries quite distinctly dusky around the exterior border but not basally.

during May, in the latitude of St. Louis, and the bulk of their larvæ are full-grown about the time wheat is in the milk. These produce moths again during the latter part of July, and, in their turn, these lay eggs which produce a second brood of worms in August. These become chrysalides toward or during September, and hibernate as such in the ground.

The habits of the worm, when full grown, are well set forth in what has been already said, and the peculiarity of feeding upon heads of the small grains is quite marked. It prefers the grain itself to all other parts of the plant, and generally leaves the glumes, or gnaws and lets them drop so as to cover the ground with chaff.

The horny outer parts of the ovipositor of the female have very much the same form, appearance and structure as in the true Army Worm (Rep. 8, Fig. 19), the compressed blade being somewhat less robust and less produced and rounded at the upper end. The eggs are also secreted as in that species, and as one might naturally expect from the unity of habit that generally prevails in the same genus. These eggs are, in fact, thrust, in single, double or treble rows of five to fifty or more in a row, between the sheath and stalk of the grains upon which the worms are destined to feed. They are generally fastened, but very slightly, to the inside of the sheath, and are readily seen upon pulling this aside (Fig. 14, *b*). They are thrust in sidewise, compactly pressed together, and not covered with any glistening or adhesive fluid as in *unipuncta.* Each egg, when examined closely, is found to be very soft and yielding, so that its form is fashioned somewhat by the pressure it receives from its neighbors and from the leaf. Normally, the form is of a compressed sphere, the depth from top to base being about half the transverse diameter. The shell is corrugate rather than granulate, the corrugations assuming upwards of thirty more or less distinct ribs. Pale yellowish and translucent when first laid, it becomes slate-colored before hatching, and the shell is so extremely delicate that every hair of the embryon may be seen through it, and it collapses and is scarcely visible after the young worm has hatched. In its rougher and ribbed surface, compressed form and other characteristics, it differs sufficiently from the egg of *unipuncta* to show that egg structure alone cannot be relied on as of much value in generic diagnoses. The eggs hatch, in Summer temperature, in from three to five days from date of deposition.

The newly hatched larva, as in *unipuncta,* is quite a looper, the prolegs on joints six and seven being still more atrophied, and those on joint eight being short. The body is pale at first, with a black head and shiny spot on top of first and last joints. It soon becomes green, with a brown head; then striped, with five pale and six darker lines, and after going through five and sometimes six molts, the worm assumes the appearance of Fig. 14, *a*, *a*. When full grown, the best marked specimens are prettily striped with sulphur-yellow and straw-yellow, and with light and dark brown, as follows: A broad, dark brown line along the back, divided along the middle by a fine white line generally obsolete behind; beneath this broad line, on each side, a straw-yellow line, half as wide; then a light brown one of the same width as the last, and becoming yellow on the lower edge; then a narrower dark brown one, containing the white spiracles; then a sulphur-yellow as wide as the third; then a less distinct light brown subventral one, the venter being pale yellow. The head is large, straw-colored, and with two attenuating brown marks from the top to the lower face.

This worm when newly hatched is, therefore, at once distinguished from *unipuncta* or the true Army Worm, by its black head; later by having superiorly five instead of seven pale lines, and six instead of eight dark ones, and when full grown, by its brighter, more strongly contrasting colors, and paler head.

The habit of feeding on the grain becomes pronounced only after the worms are half grown, and prior to that time they feed on the leaves, and are seldom noticed.

The chrysalis is naturally formed just beneath the surface of the ground, but frequently under weeds and other rubbish. It is of the ordinary mahogany-brown color, terminates in a stout horny point, with a corrugated base, and is at once distinguished from *unipuncta* by the stigmata being raised on a rounded prominence, and by other particulars mentioned in the description at close.

The worms acquire their full growth in from three to four weeks from hatching, those of the second brood developing somewhat more slowly than those of the first. The chrysalis state in the Summer brood lasts from ten to fifteen days. The parent moth (Fig. 15) has the front wings pale, straw-colored, with a white line running along the middle to the outer third, and shaded with brown and purplish-brown as follows: A shade beneath the white line, intensified at each end where it joins the white; another along the posterior border, narrow at apex and broadening to the middle, where it projects along the middle of the wing above the white line, fading away toward base, and a fainter shade along the front or costal edge, intensifying toward apex.

NATURAL ENEMIES.

The worm is subject to the attacks of three distinct parasites. One, the very same species of Tachina-fly (*T. anonyma*) which I have so often bred from other insects; the other a pretty Ichneumon-fly (*Anomalon apicale* Cresson) which may be called the Dark-tipped Anomalon.

Of a lot of over a hundred chrysalides received from Mr. John Davis, Junction City, Kansas, fully forty per cent. were destroyed by this parasite, which undergoes its transformations within the chrysalis shell, spinning but a very thin layer of silk on the inside thereof, and issuing finally by gnawing and pushing off the anterior portion.

It is rather a pretty species, about 0.90 inch long, exclusive of antennæ. The wings are smoky-brown, with deeper brown veins, a golden reflection toward base, and a clearer space at tip of front ones. The face and cheeks are pale yellow, with the top of head and eyes black. The thorax is marked with yellowish-brown and black and the compressed abdomen is reddish-brown, with the truncated end more or less black. The legs are generally pale, with the exception of the thighs and tips of shanks, which are darker.

The third parasite is a genuine Ichneumon (*Ichneumon brevipennis*) originally described by Mr. Cresson from Colorado. It may be popularly called the Short-winged Ichneumon and is characterized by its pale reddish-brown color and short, smoky wings.*

REMEDIES.

It is quite evident from the foregoing history of this destructive worm that the practical means of counteracting its injuries are chiefly preventive. It cannot be successfully fought in the worm state, and the wheat grower who has been troubled with it should direct his attention to the destruction of the chrysalides by late plowing and harrowing and to the capture of the moths in Spring by means of lights and sweetened and poisoned fluids. We can hardly hope that such preventive measures will be very generally adopted, especially as at best they would prove but partially successful; and I confess that the species, from the character of its food and of its life-habits must be, with our present knowledge, placed in the category of insects whose management baffles man, and must be left to the work of their natural enemies.

DESCRIPTIVE.

Leucania albilinea—*Egg*—0.5 m.m. wide, generally but half as deep, the top and base being quite flattened. Color pale-yellowish, translucent and less iridescent than in *unipuncta:* with rugosities which assume on upward of 30 more or less distinct ribs: becoming slate colored before hatching: shell extremely delicate and generally collapsing after exit of larva.

* The specimen, which Mr Cresson has kindly compared with his type, differs therefrom in having the wings relatively longer and in the narrow black bands at basal margin of abdominal joints 2, 3 and 4, being obsolete. It may be distinguished as a variety of *brevipennis* for which I propose the variety name *obsoletus*.

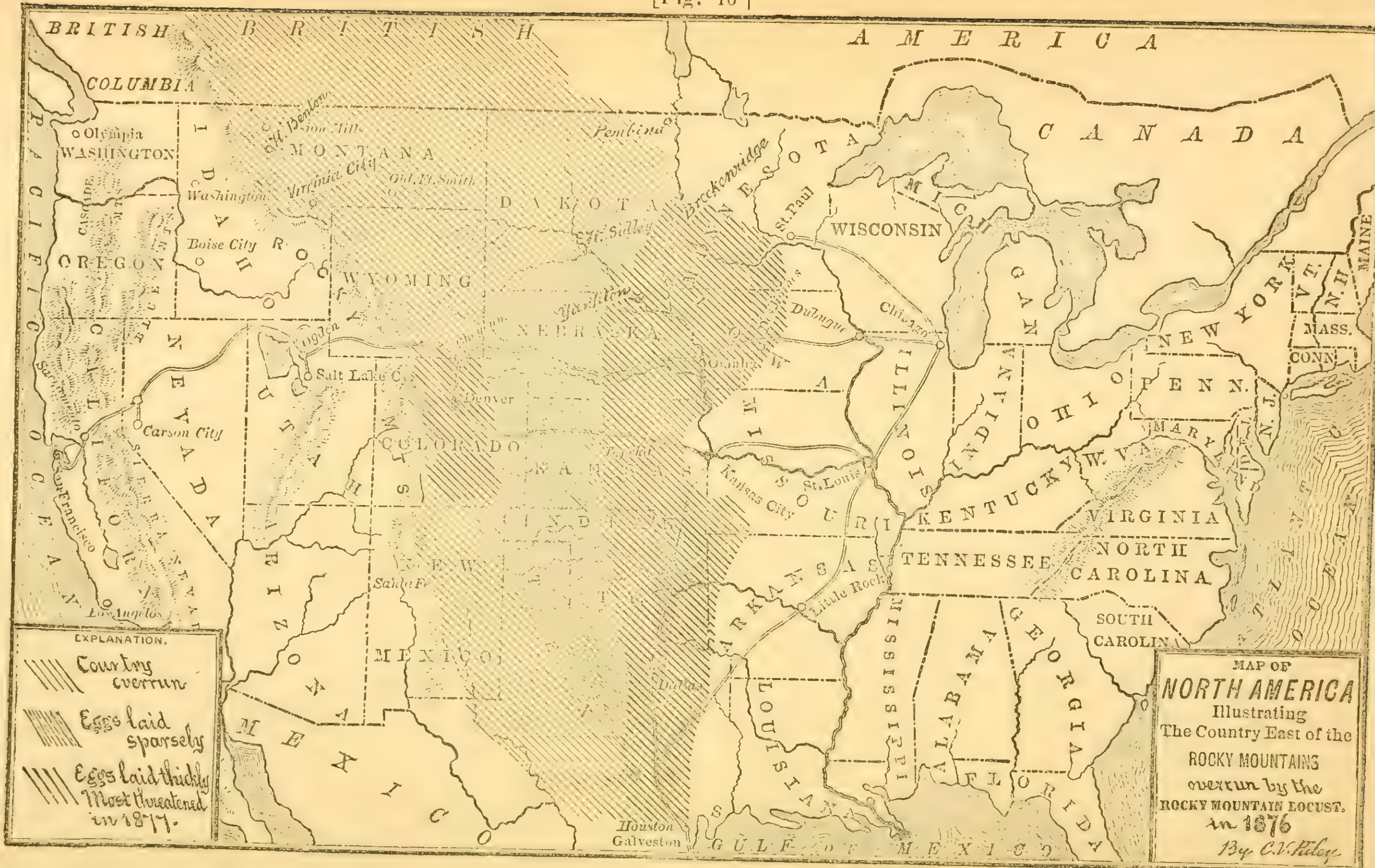
Larva—Newly hatched larva 1.9 m.m. long. Like *unipuncta* quite a looper, the prolegs on joints 6 and 7 very much reduced and useless. Head, cervical shield, and shield, thoracic legs, rings on prolegs, piliferous spots which are conspicuous and normal in position, and bristles from them—black. General color sordid white, soon becoming green. In the *second stage* the black parts become brown, and the body above shows five pale lines on a ground of six dark ones, (in *unipuncta* there are 7 pale and 8 dark ones) generally indicated in the latter part of the first stage. In the *third stage* the head is gamboge-yellow, and the dark lines are olivaceous and the contrast with the five pale lines and the pale venter more decided. The looping habit is also abandoned. In the *fourth stage* the head is honey-yellow with the mature markings indicated in brown, and the five pale superior lines, especially the mediodorsal and the next to it which is broadest, are relieved more strongly by a deepening of the borders of the dark lines. In the *fifth* and *sixth stages* the characters of the mature larva are approached by the narrowing of the medio-dorsal pale line, the deepening of the dorsal and fading of the subdorsal dark space; by the separation of the subdorsal pale line into two, and by the deepening of the stigmatal dark line.

Mature Larva—Average length rather more than an inch. Colors pale yellow and brown. The brighter marked specimens have the dorsum brown with a narrow medio-dorsal yellow line, obsolete posteriorly; then a subdorsal sulphur-yellow line ½ as wide and suffused in middle with carneous; then a still narrower brown line, ill defined, beneath; then a yellow line of same width as preceding; then a somewhat broader brown-black stigmatal line; then a substigmatal sulphur-yellow line as broad as subdorsal and generally relieved below with pale brown—all the dark parts, except the black stigmatal line, speckled with yellowish. Venter dull white. Head large, wider than body, pale yellow—almost white, with brown tipped jaws, mottlings on the cheeks, and two broad brown marks (with a tendency to fade in the middle) on top, narrowing each side of V-shaped sutures. Stigmata white, with black annulus. (In unipuncta they are dark with a pale annulus). Piliferous spots though more conspicuous than in *unipuncta* in first stage, now less so. Varies considerably, some being quite dark and others greatly suffused with rosaceous; but the pale head, dark stigmatal line and bright yellow lines are constant.

Hundreds of specimens examined. Chrysalis—normal form, and dark mahogany brown. Distinguished at once from *unipuncta* by being more strongly punctate; by the anterior border of the three abdominal joints immediately below the wing-sheaths being but slightly ridged, and deeply, profusely and irregularly punctate all round; (in *unipuncta* these joints have, above only, a clearly defined ridge with a single row of larger and regular punctations) by the stigmata being raised on a rounded prominence; and by the anal joint being much broader and more corrugate at base.

Imago—Average expanse 1.50 inch. Front wings either pale straw, or ochre-yellow with a pale or white line along the median vein, broadening to the disc, and sometimes extending more or less along veins 3 and 4; tapering to base and blending more or less with another pale line which extends a short distance beneath it and fades away posteriorly, each sharply relieved below by a brown-black streak, shaded with brown as follows: a broad pale costal border having a cinereous shade, with the veins, especially towards apex, relieved and pale; a terminal shade with similar cinereous hue, and tapering to apex; a broad shade beneath median white line, with frequently a dark, elliptic streak at its lower border toward base; and generally (not always) connecting more or less distinctly with the terminal shade; and lastly, a cuneiform shade connecting with the terminal from vein 4 to apex, from which it curves abruptly and tapers along the upper border of the median white line, which it helps to relieve. A small discal dot. The tapering shade is generally very clearly relieved by dark streaks at its borders. Fringes white, usually with a dark medial line, and always with a pale inner line relieved by a dark terminal line. Beneath white, with a faint dusky tint opposite the cuneiform shade. *Hind wings*, satiny-white, with frequently a faint dusky shade posteriorly in the ♂. *Head* ochraceous-brown with paler

[Fig. 16]


MAP OF
NORTH AMERICA
Illustrating
The Country East of the
ROCKY MOUNTAINS
overrun by the
ROCKY MOUNTAIN LOCUST,
in 1876
By C.V. Riley
EXPLANATION.
Country overrun
Eggs laid sparsely
Eggs laid thickly Most threatened in 1877.
BRITISH AMERICA
BRITISH COLUMBIA
CANADA
PACIFIC OCEAN
GULF OF MEXICO
MEXICO
WASHINGTON
Olympia
OREGON
IDAHO
Boise City
MONTANA
Virginia City
DAKOTA
Pembina
WYOMING
NEBRASKA
Yankton
Omaha
UTAH
Salt Lake C.
Ogden
NEVADA
Carson City
CALIFORNIA
San Francisco
Los Angelos
COLORADO
Denver
KANSAS
ARIZONA
NEW MEXICO
Santa Fe
MINNESOTA
St. Paul
Breckenridge
WISCONSIN
MICHIGAN
IOWA
Dubuque
ILLINOIS
Chicago
MISSOURI
St. Louis
Kansas City
ARKANSAS
Little Rock
LOUISIANA
Houston
Galveston
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
W. VA.
MARYLAND
PENN.
NEW YORK
N. J.
CONN.
MASS.
VT.
N. H.
MAINE

palpi. *Thorax* of the same color, paler behind; the collar pale lilaceous, with a white upper border strongly separated from the dark anterior border of tegulæ; three white streaks, one medial and one on each tegula. Anterior legs dusky in front, otherwise, with body, ochraceous. Antennæ simple; having but the faintest fringe of hairs in the male. Eighty-four bred specimens from wheat-feeding larvæ examined.

The above description applies to typical Western specimens of the Summer brood.

As in every case where I have studied large material, the species proves quite variable. The dark marks may have an olivaceous hue, or they may so predominate as to form the ground-color of primaries, with the white medial line well relieved, but the pale shades above and below it reduced to streaks. The discal spot is either obsolete, single, or double, and somewhat reniform; the orbicular spot is sometimes indicated; the tapering dark shade inclining from apex reaches either to disc only, or extends to base of wing; the brown-black streaks may be sub-obsolete; the apical angle varies in acuteness, and the posterior border in obliqueness; the terminal line may be broken into more or less distinct dots; and finally, there may be a series of distinct dots between the veins along the inside of terminal shade, and streaks between the veins, recalling *phragmatidicola*.

Not one of the Summer brood has the hind wings "smoky, blackish" that characterizes *Harveyi* as described by Grote; but two Spring-bred specimens, below average size, accord with his description very well, even to the narrower primaries and scarcely obliquing posterior border. *Harveyi* (and perhaps also Hübner's figure) may, therefore, be considered the Spring form of *albilinea*, just as I have proved by breeding that *Pieris vernalis* is but the Spring form of *P. protodice*. Indeed the tendency to smaller size and deeper color in broods that hibernate in chrysalis is very general.

THE ROCKY MOUNTAIN LOCUST—*Caloptenus Spretus*, Thomas.

[Ord. ORTHOPTERA; Fam. ACRIDIDÆ.]

This scourge has continued to vitally concern our people and the people of the western country east of the Rocky Mountains. After the fearful ravages which it committed in 1874 and 1875, it will be interesting to take note of its doings in 1876.

It will be remembered, that, in opposition to contrary opinion widely circulated, I expressed my belief, a year ago, that in Missouri, Kansas and Nebraska, first, there would not hatch as many locusts in the spring as would naturally hatch in ordinary seasons from indigenous species; second, that, compared with other parts of the country, those States most ravaged by locusts in the spring and early summer of 1875 would enjoy the greater immunity, during the same season of 1876, not only from locust injuries, but from the injuries of most other noxious insects; that, in short, the people of the ravaged section had reason to be hopeful rather than gloomy; that they certainly would not suffer in any general way from locust injuries in the early season; and that the only way in which they could suffer from the migrating pest was by fresh swarms, later in the year, from the far Northwest.—Rep. 8, 155–6.

Like the other opinions as to the future doings of this insect that I have felt warranted in expressing in an unqualified way, this last was fully justified by subsequent events.

From most of the Western States the crop returns were favorable, though the harvest was in many sections impeded, as it was in 1875, by too much wet weather. In no part of the country was the outlook more flattering than in western Missouri, Kansas, Nebraska, Iowa and the country so seriously ravaged by locusts the previous year, and the farmers throughout that section of country had seldom been freer from insect ravages, or more hopeful. The freedom from other noxious insects was everywhere apparent in our own western counties. In parts of the Northwest, as in the East, the conditions were very different from what they were with us, and the crops suffered more or less from excessive drouth. In Colorado, early in the season, there was some alarm, as the insects hatched in many localities, but by no means so generally as in the previous years. By persevering effort the farmers generally got the mastery over them and have made good crops. In Minnesota, again, in some of the southern counties, where eggs were laid, considerable damage was done, though nothing like as much as in 1875. During the second week of July the locusts took wing from that region, and it is interesting to note that they instinctively took a north and northwest course, just as the fledged insects had done a few weeks earlier in the season from Missouri and the adjacent country to the west the year before. Numerous dispatches to St. Paul, Minneapolis, and other papers, show conclusively that the general direction taken was northwest, and that when the wind was unfavorable the insects awaited a change.

Such was the condition of things up to the early part of August, and I began to hope that the country that had suffered so much of late years by locust devastations, was at last free from the scourge, and would not be overrun again for some years to come. But the great drouth which prevailed in the Northwest appears to have favored the multiplication of the insects in, and their migration from their native haunts, and no sooner had the people begun to congratulate themselves on the good riddance of the pests, than reports came of the movement of new swarms from the north and northwest. From that time on, till the approach of Winter, their movements were reported and they overswept a large part of the Western country.

On the assumption that the hosts that went to make up the invasions of 1873 and 1874 had made an exodus from their native breeding places, and that those, if any, which returned thereto in 1875 were more or less diseased, it was natural to conclude that a few years would be required for the species to again become unduly multiplied there and be constrained to migrate. The intervals that had elapsed in the past between general invasions favored such reasoning. The fact that the insects had hatched out in immense numbers, in 1875, as high up as British America, from 1874 swarms that had come from the still further north and west,* was then not known to me; and the experience of 1876 proves how little we know of the native breeding haunts of the species, and that the past history of invasions is no certain guide as to the future.

THE INVASION OF 1876.

In order to give a correct idea of the invasion of 1876, I will consider it by States and Territories, and, as far as possible, in chronological order.

BRITISH AMERICA.—In Manitoba, as I learn from Prof. Dawson, the insects did not appear in sufficient numbers to attract attention or do any harm to crops, which were very good, nor were any eggs laid there. Far west of Manitoba, however, he has reason to believe that the insect was produced from the egg over a pretty extensive area north of the 49th parallel, and that such was really the case is substantiated by Mr. Chauncy Barbour of the *Weekly Missoulian*, Missoula, M. T., who wrote me July 21st, that travelers in Spring from Ft. McLeod, British America, some 300 or 400 miles northeast of Missoula, reported vast numbers of the young insects there.

MONTANA.—The insects hatched extensively in this Territory and no doubt went to largely make up the swarms that subsequently reached over the country to the southeast. The Monthly Report of the Department of Agriculture for May and June mentions them (in its usual inexact way, without dates) as occurring in millions and damaging Spring crops, especially wheat, in Deer Lodge, Lewis, Clarke and Jefferson counties; and the following item is quoted by Prof. Whitman from the *Bismark Tribune* of June 14, 1876:

IN THE FIELD, NEAR ROSEBUD BUTTES, May 29, 1876.

"As we move westward the grazing improves, and here in the Little Missouri Valley the season is at least a month in advance of the season on the Missouri. This would be a splendid grazing region, were the water good. The grass is heavy and nutritious, but the water is strongly impregnated with alkali. Millions of locusts are just now making their appearance in this region. Too young to fly or do much harm, in a few days, should the winds favor them, they will sweep down upon the defenceless agriculturalists on the border, doing untold damage."

The Signal Service reported them as being numerous all over the Territory in June, as flying over Virginia City, southwest, during the middle, southeast during the end of July, southeast in myriads from the 1st to the 5th of August, and as continuing to pass throughout the month until the 29th, when their numbers decreased. No eggs reported.

WYOMING.—Reports from Cheyenne show that the insects were abundant throughout the month of August, passing to the southwest, and that swarms were also passing south and southeast on a number of days in September.

DAKOTA TERRITORY.—As already indicated, the insects that had hatched in Minnesota, departed during the fore part of July, mostly in a northwest direction. During that time the winds were for the most part strong from the southeast, and the locusts were carried over Southeast Dakota, and were noticed to be particularly thick at Vermillion. From the 10th of the month the wind was mostly from the northwest,

* See the facts mentioned in discussing the source of the swarms of 1876, further on.

and the insects poured from that direction into the same country that they had previously left. These swarms were doubtless made up of the very insects that had shortly before left Minnesota, reinforced by others that had lived in the Territory; for they were flying at Pembina, mostly south and southeast from the 8th to the 20th of July.

At the Omaha Conference Gov. Pennington stated that the young never hatched in Dakota, founding his statement on the fact, doubtless, that individually he had never seen them around Yankton. I stated at the time that the reports from Signal Service eporters proved the statement incorrect, and the reports for 1876 from various parts of the eastern and southern portions of the Territory show that the young hatched out there early in the season, as they did in parts of Minnesota.* The Signal Service reports them even far to the north at Pembina, as appearing in June.

From the reports, it is evident that after the first week in July the swarms took a south and southeast direction; further, that until toward the beginning of August they were scattering, did but little damage and laid no eggs—thus indicating that they came from but a short distance. By the first of August, however, and from that on, the swarms were more and more dense, extensive and disastrous, indicating that they had come from a greater distance. It was reported from Yankton, August 2, that the Indians would lose half their crops, but the reports generally during the early part of the month were very contradictory, while those received during the latter part of August showed that the locusts were doing but little damage, and that there had been much exaggeration, especially as to the injury in the Red River Valley. The elevators and warehouses in Yankton were doing a large local business in the Fall. Gov. Pennington represents the damage to wheat at only 5 per cent., and states that corn was one-fourth to one-half a crop. Eggs were laid in the extreme southwest corner, but principally, I think, by the insects from Minnesota. Considerable injury seems to have been done to fruit trees, which in many localities were stripped. Such trees put out fresh leaves and even bloomed again, and it was noted that a frost in September, which stripped most trees of leaves, left the new growth on the locust-stripped trees untouched. I have observed similar results elsewhere.

MINNESOTA—Less fortunate than the States to the South, a good supply of eggs was left in the ground in 1875 in some of the more sparsely settled counties to the Southwest, including Murray, Cottonwood, Watonwan, Brown, and parts of the adjoining counties. Many of the farmers were unable to get large amounts of seed-wheat, after three years depletion. The average sown to small grain was, therefore, small. Yet, from statistics furnished me by J. B. Phillips, Commissioner of Statistics, the estimated yield of wheat in the State, notwithstanding all drawbacks, was over 15,000,000 bushels. After the grain was up and the locusts had began to hatch, it was considered in many cases to be more profitable to seek the certainty of employment elsewhere, than to take the chances of (at best) a small crop at home. But there were quite a number of cases in which men, by using various means, succeeded in saving half or two-thirds of a crop; and reviewing the situation in Blue Earth county, the Mankato *Review* of August 15, says:

> It is a notable fact, worthy of mention, in this connection, that the grasshoppers were very bad in the town of Rapidan, but under the vigorous fight instigated by the county and local bonus, the loss was comparatively light—only 6,570 bushels, and the average yield of the town, not including this loss, was about 16 bushels to the acre. The town of Lyra was much less affected by grasshoppers, yet its loss is nearly 2,500 bushels in excess of Rapidan, a sum more than sufficient to pay the local bounty of the latter town.

* See, more particularly, the records published by Mr. Whitman in his "Report on the Rocky Mountain Locust for 1876."

During the second week of July, these home-bred locusts took wing, and it is interesting to note that they instinctively went in a north and northwest course, just as the fledged insects had done a few weeks earlier in the season, the previous year, from Missouri, and the adjacent country to the west. Numerous dispatches to St. Paul, Minneapolis and other papers, show conclusively that the general direction taken was northwest, and that when the wind was unfavorable, the locusts awaited a change.

The exodus to the northwest was, however, by no means so general as from the more southern country the year before, and, as I learn through Mr. Whitman, many of the insects remained and commenced laying early in July, within two weeks after they had commenced to fly, and not many miles from their hatching grounds. This has never occurred in our own State, and simply indicates what I have in these Reports maintained, viz: that Minnesota is so much nearer the native home of the insect that the species can sustain itself for a longer time there.

The swarms that left early in July returned, did more or less damage, and toward the end of the month left in numbers in a southerly direction. Some, however, remained. About the 6th of August fresh swarms came from Dakota, having been heard of on the 23d of July as passing over Gen. Crook's army. These, as I learn from Mr. John C. Wise of *The Weekly Review*, Mankato, by letter of August 22, pushed continuously to the southeast, and reached as far east as they were ever known to do, or as far as the southwest corner of Dodge county.

The Pioneer Press and Tribune of the 19th remarked:

They appear to have left the southwestern counties and moving northward, have settled down on strips of land, to a width of 65 miles, extending from the upper part of Nicollet county to Minnesota Falls; south to a line drawn between these points there are but few hoppers reported, and they are not doing any damage—but they extend northward up to Otter Tail county and beyond.

They were found at intervals over that whole country, depositing eggs, doing much damage in some localities and scarcely any to others. They came too late to do much damage to the principle crops, which were mostly harvested. If we study the reports from the south and southwestern parts of the State, published in the journal aforesaid, we find that from one-half to two-thirds of a crop of the small grains had been harvested on an average in the worst visited section, and drouth and other insects, such as the Hessian-fly had much to do with the poor yield. The eggs were extensively destroyed not only by the Silky Mite, but by the Anthomyia Egg-parasite, and the Ichneumon grub, which I shall describe further on. It was further noticeable that the insects came down with the northwest winds, and that when the wind changed to the south, as it did for several subsequent days, few of the insects returned with it. The great bulk of them were restless and remained till the winds shifted again to the north and northeast. Another noticeable feature was that the eggs were quite generally laid in very moist ground, as there was abundant rain about the middle of August. Throughout the month of September the insects were moving mostly south and southeast, spreading, but very gradually, further and further east. Many of them remained and continued laying till frost.

The fact, that in their previous invasions into Minnesota the locusts had never penetrated farther east in Blue Earth and Nicollet counties than the Minnesota river, led there, to the advancement of a theory that they are peculiar to and thrive only in an alkali region. This is the character of the region west of the Blue Earth river, across which they, seemingly, had never ventured to any extent, and certainly had never prospered.

In answer to an inquiry on the subject last August from Mr. Wise, I stated my belief that there was no ground for the theory, and that I had more faith in the other causes which I have discussed as limiting the eastward spread of the species. Subsequently the insects extended some distance beyond the river in question. Indeed, they reached a full degree further east than in previous known invasions, extending from Clay county to a little west of St. Paul, and thence to Dodge and Mower counties.

Eggs have been laid more or less thickly over the larger part of the southwest half of the State. Mr. Whitman has carefully mapped out the area, and it includes most of the country southwest of an eastwardly bulging line drawn from Clay to Mower counties, or about four times the territory in which eggs were laid in 1873, and about five times that in which they were laid in 1874 or 1875. It is a singular coincidence, however, (and something similar will be noted in Kansas and Missouri further on), that, as reported by Mr. Whitman, those counties in which the insects hatched in Spring, and where vegetation was mostly consumed, are most nearly free from eggs.

Governor Pillsbury has, from the first, taken a lively interest in the suffering of the farmers from this plague, and by a timely proclamation, setting forth the best known means to be used against them, and in other ways, has done much good. He devoted considerable space to the subject in his last message, and urged legislative action, not only on the part of his own State Legislature, but on the part of Congress. As a result of his efforts, and the liberal policy pursued in having investigations officially continued by Prof. Whitman, the people of the State, by means of organization and ingenious machines, are better prepared to meet the enemy next year than are those of any other State. The legislature also has recently passed two bills which are important in this connection; the one appropriating $75,000 for seed grain to the destitute, the cost of the grain to be assessed against the property of the person receiving it, and paid, as other taxes, in two equal assessments, whenever the recipient shall have raised two crops; the other provides for a bounty of $1.00 per bushel for all grasshoppers caught previous to June 1 next, with smaller compensation thereafter as the insects approach maturity.—(See further on under "Legislation.")

Colorado.—What with persistent and generally successful fighting by farmers, with burning machines, ditches and coal oil, together with their natural enemies and the heavy rains, the insects that hatched out in Colorado had greatly diminished in June, and those that took wing vanished without leaving any very strong impression as to the direction taken.

During the early part of August the locusts were passing over large parts of Colorado from the north, in a southwesterly direction, at the rate of about fifteen miles a day. They came in successive and almost continuous clouds, and the general opinion was that they came from Wyoming. The small grain was mostly saved throughout the State, but all late and green crops suffered. The *Colorado Farmer* (Denver) of the 10th of August, stated that, while the damage had been great, it was quite probably over-estimated; and the same journal a week later, reported that the insects had very generally left that part of the State. According to Signal Service reports, they had also very generally left by the 13th, but others were passing over from the 22d to the 28th, and thenceforward in diminishing numbers. Toward the end of the month they were very thick along the Denver and Rio Grande Railroad, frequently impeding the trains.

The *Georgetown Miner* gives the following account of their drowning in large numbers:

> * * * As the ravenous millions were driven up against the high ranges about Mount Evans, they were chilled and commenced falling into the little stream which flows past Sisty's place, until for days, the rivulet was transformed from

a sparkling stream of limpid water, into a floating mass of dead grasshoppers, the water becoming so corrupt and offensive that neither man or beast could tolerate it. The trout pond in Mr. Sisty's meadow became so putrid that he was compelled to cut away the dam and let the accumulated filth flow off. Mr. Sisty says that he never before witnessed such a phenomenon. The theory is, that a cold shower along the range threw down the dense swarms of insects, which were drowned, and the little tributary streams swept them into the brook in such numbers that it required days for the whole to be carried away, while the masses that had accumulated in the eddies, decayed, imparting putridity to the waters.

Mr. Stanger, of the *Colorado Farmer*, tells me that the flight of the great clouds that were far up in the air, was invariably southwest over Denver, and he believes that eggs were laid over the whole traversible territory of the State.

Iowa—As in a few of the S. W. counties in Minnesota, so in adjoining parts of N. W. Iowa, and notably in Osceola and Dickinson counties, the young insects hatched out from eggs laid in 1875; but, as Mr. J. M. Jenkins, of La Mars, writes me, they had entirely disappeared by the middle of June, either dying of inanition, being devoured by their various enemies, or moving off to the N. W.

About the first day of August, the northwestern counties of this State were visited by heavy swarms. They appeared to cross the State line from Dakota and Minnesota at almost exactly the same date for Emmett, Dickinson, Osceola, Lyon, Sioux and Plymouth counties, and from here they swept at once out into the counties lying eastward and a little to the south. The direction of flight was a little south of east, and the rate at times eight or more miles an hour. The insects were at times so thick as to darken the sun, and to impede trains. That the invasion was from the northwest may be readily seen by consulting a map in connection with the following data furnished by Prof. Bessey of the Agricultural College:

Lyon county, commencement of harvest.

Sioux county, July 27.

Plymouth county, last week in July.

O'Brien county, July 27 or 28.

Pocahontas county, August 1.

Cherokee county, August 6.

Monona county, August 10.

Audubon county, about the middle of August.

Harrison county, August 18.

Carroll county, August 18.

Sac county, August 23. Apparently in northwestern part of county about a week or ten days before.

Pottowattamie county, August 23.

Hamilton county, August 30.

Boone county, first week in September.

Hancock county, September 8.

Guthrie county, from 1st to 10th of September.

Story county, first noticed about the middle of September, flying over in considerable numbers.

The amount of damage done, as shown by all obtainable data, was not so great as in former years. Some lucky sections in the area traversed by them escaped entirely; though a few counties, and particularly those first visited, suffered very heavily. The loss to Lyon county was three-fourths, to Sioux, one-half, of all crops. In Plymouth county corn was damaged two-thirds. Monona and Harrison report injury to corn from 10 to 20 per cent. In Pottowatamie county their preference for nursery-stock and garden vegetables made their injury to the grain-grower comparatively slight. This was the case, also, in Sac county, where they were represented as making raids on garden produce, and leaving corn almost an immunity from attack. O'Brien county reports the destruction of all uncut small grain, garden vegetables and most of the corn. In Cherokee potatoes were damaged about 75 per cent., corn 25 to 33 per cent., and Fall wheat considerably; and in Carroll corn was injured 25 per cent., and cabbages and turnips devoured "in toto". These are the worst cases. Hamilton county suffered a small loss in late potatoes, Fall rye and cabbage; in Audubon the damage did not exceed one per cent., and the counties of Boone, Story and Guthrie almost entirely escaped damage.

The most eastern point reached was in the middle of the State, and the line retreats from Story county both north and south.

In all the counties invaded, eggs were deposited, and in most instances quite thickly.

Prof. Bessey republished the remedies and recommendations in my last Report, and issued them in a little bulletin, that was easily and cheaply sent to farmers throughout the State.

NEBRASKA—Those locusts that came into Iowa earlier in August passed southwest into Nebraska, and, in scattering numbers, reached Council Bluffs and Omaha August 17. A dispatch from Omaha the next day summed up with the statement that: "a general review of the situation was very favorable, and there was no apprehension of a failure to harvest the fine and large crop."

From many other reports it would appear that in the northeast counties, from locusts and other causes, not more than half a crop of corn was saved, but that most of the small grain was duly harvested; and Mr. L. W. Chandler, of St. Helena, wrote, toward the end of the month, that notwithstanding the injury to corn, the country thereabouts was in better shape than it had been for five years.

Almost simultaneously with the incursions in the eastern part of the State, there were others from the north overrunning the western part, and from the 5th of August throughout the month, their movements were reported by the Signal Service. The direction was principally south, or southwest early in the month, and mostly southeast toward the end of the month; and here, as in Minnesota, it was everywhere remarked that when the wind was from the south, the insects remained and awaited a change before passing over in the main direction. The following account from a correspondence of the New York *Tribune*, gives some interesting details:

> Early in August they reached the western portions of this State, but were partial in their depredations, devouring everything in some localities, doing little damage in others. On the twelfth of the month they made a forward movement, and appeared in the valleys of the Elkhorn, Platte and Republican. Our local papers, acting on the "ostrich" policy, suppressed the facts or misrepresented them, and all were wishing for a favorable wind to carry the pests beyond our borders. But a soft, southerly wind, varied by an occasional thunderstorm from the northwest, prevailed till the 23d, when, by a stiff northwester, the grasshoppers rose and came from their exhausted feeding-grounds upon the east and south portions of the State. They came literally in clouds, looking like the frost-clouds that drift along the horizon on a winter morning. They are devouring "every green thing," including shade trees and even weeds, such as the "Jamestown weed" and wild hemp. The great body of them seemed to pass south, moving in dense masses during the 23d, 24th and 25th, and will probably be heard from in Kansas and Missouri.

Eggs have been laid all over the eastern part of the State, but less extensively in the western counties. Ex-Governor Furnas thinks that there are few in the counties over one hundred miles west of the Missouri river, and, regarding the young insects next Spring, he remarks, in a recent letter, "that while in the West we have room for millions more people, and are glad to have them come, and with us occupy and utilize the broad fertile acres God has bequeathed to the Far West, those who have not "sand and grit" enough to clean out a crop of young locusts are not the men wanted! I repeat what I said to you at the Convention in Omaha, and am prepared to demonstrate the truth of the assertion: that any thrifty, energetic farmer can exterminate the most extensive stock of locusts, on any one farm known, with less labor and expense than he can get rid of an ordinary crop of weeds."

Prof. A. D. Williams, of Kenesaw, Adams county, writes:

It is safe to say that eggs were laid in every one of our sixty settled counties. Not one has escaped. But the amount of eggs in the western part of the State, where they appeared earliest, is much less than in the eastern portions of the State. There is undoubtedly a gradual increase of eggs, all the way from the western to the eastern line of the State—the river counties suffering much the more severely. The amount deposited there is beyond all estimation, while west of Kearney there is not a very large amount.
* * * Upon the whole, I incline to the opinion that the casualties of the season, the depredations of the birds and the efforts of the homesteaders will so diminish the number of locusts in the Spring, that small grains will be raised in the western part of the State. But I fear that unless Providence is unusually favorable, and the people bestir themselves unusually to fight the locusts, very little, save corn and late crops, will be raised in the river counties. * * * *

The actual damage done by the locusts last year, in Nebraska, was fully equal to that done in 1874. But the greater abundance of small grains, and the greater reliance of the people upon stock and a more diversified industry, have saved us from the destitution of that year, and largely disarmed *Caloptenus spretus* of his terrors.

KANSAS.—A review of the invasion in Kansas shows it to have been in the main from the north and northwest. The insects came into the northwest part of the State late in July and early in August and were seen flying about in many directions, but mainly southward, during the whole month. Early in September the swarms thickened, and the wind blowing almost a gale from the west on the 7th and 8th of the month, and strong from the west and northwest for two or three days subsequently, the insects during that time swept down in darkening clouds over the greater portion of the State from the 98th meridian to beyond the 96th. The following extracts from my correspondence indicate the nature of the invasion:

I drop you these lines to let you know that the locusts called on us to-day in force. This morning the wind was blowing from the northwest, and as the day advanced the air was filled with a cloud of locusts as thick as any I ever saw before. Toward evening they came down and are resting to-night. They do not manifest much tendency to eat, but may by to-morrow. * * * [Robert Milliken, Emporia, Lyon county, Sept. 9, 1876.

* * * I am sorry to say that the locusts are still with us, more plentiful than I ever saw them before. As I wrote you before, they made their first call on the 9th, and more plentifully on the 11th, the wind blowing from the north and northwest most of the time from the 9th to the 14th; they traveled before it, except when it was too cool for them to fly, as was the case on the 12th and partly the 13th, but on the 14th they were so thick that the cloud fairly darkened the sun. The 16th, 17th and to-day the wind has blown from the south and they have not flown to amount to anything. They are pairing almost universally and are commencing to deposit eggs. Not enough eggs are yet left to make any serious trouble in the Spring, but if they stay another week I tremble for our prospects.—[*Ibid*, Sept. 18, 1876.

The locusts came to the line of the Santa Fé Railroad from Hutchinson as far west as Grenada, about the 25th day of August, 1876, brought by a north by northeast wind. They came in great dark clouds for one day (the 24th) at this place, Sterling, Rice county, Kansas. They mostly passed over here to the south and southwest. A few lit upon us and devoured corn blades, potato leaves and some other toothsome herbage. Little real damage is done as yet to crops. Some of the early wheat is eaten and killed and farmers are generally holding off to sow after the locusts leave. A few returned with south winds, but on the 31st, at 2 P. M., the wind changed to north and nearly all took wing. But great clouds came fresh from the north and the face of the earth was alive with them. A northeast wind, September 1st, carried the greater part of them with it to some place distant from here. Enough remain to do some damage to vegetation and the south winds bring them back, not in great dark clouds as from the north, but some every day. They seem to float about with the shifting winds, perhaps for food, but when the wind gets north they go in swarms. That shows their tendency to migrate southward. Those that remain are laying eggs.—[H. E. Van Demen, Sterling, Kansas, Sept. 6, 1877.

* * * Such a host of insects I never saw. The gronnd is completely covered and the branches of the trees are bending down with their weight. In my orchard of nearly twenty acres the trees are covered by myriads. Two hundred Siberian crab-apple trees, next to the house, are completely defoliated, and the grove on the north is one huge moving mass.

Our corn crop is splendid, and I think is so far advanced that it will not be materially injured. Thirty acres of wheat which looked beautiful and green in the morning is eaten up. Six hundred and forty acres, two miles south of me, that was looking fine at the beginning of the week, looks this morning as if fire had passed over it. A large acreage has been sown in this county earlier than usual. I suppose it is all gone. —[Jno. W. Robson, Cheever, Dickinson county, Sept. 8, 1876.

Mr. H. A. Brous, a former pupil of mine, who spent the whole Summer in Western Kansas, in company with Prof. B. F. Mudge, kept a careful record of the movements of the locusts, and has sent me the same. From this record it is interesting to note that the western part of the State was just as free in Spring and early Summer of the *Caloptenus spretus* as was the eastern, and that none but the genuine *femur-rubrum* and different species of Œdipoda, and of other genera, were noticed. The first specimens of *spretus* were seen in Wallace county August 5th, flying south from 10 A. M. to 4 P. M. From that time forth they were noticed almost daily flying in different directions, but thickest when from the W. and N. They were most numerous on the 12th and 13th, and on the 24th they were again very thick in Gove county—in both instances flying S. S. W. and S. W. During September the direction also varied, but was most often to S. W. The highest and heaviest swarms were, however, to the S. On a number of days two distinct strata or currents were observed. Thus, on September 1, there was an upper current going W. and a lower one going S. W.; on September 2, an upper S. W., a lower N. W.; on September 9, an upper S. W., a lower S. E. E. In October there were few noticed.

The damage done, though serious enough, was less noticeable than in 1874. Vegetables and Fall wheat suffered most; one extensive wheat-grower (Mr. T. C. Henry, of Abilene,) losing 2,500 acres. A great many farmers sowed again, and plowed the soil under, believing that where not sown early enough to come up in the Fall, it is best that it should not come up till Spring, and that an average crop under such conditions can be grown.

They reached east, according to the records I have at hand, to a line drawn a few miles west of Lawrence, including the larger part of Brown, Doniphan and Atchison in the N. E. corner; portions of Jefferson, Douglas, Franklin, Anderson, Allen and Neosho, and most of Labette, Cherokee and Crawford counties in the S. E. Bourbon, Linn and Miami were only partly overrun; Johnson and Wyandotte escaped entirely, and most of Leavenworth was untouched. In nearly all of the more thickly-settled country invaded, eggs were abundantly laid; and the insects remained laying until buried by the first snows. In the western third of the State, where the insects came earlier, few or no eggs were laid. It will be noticed that the very counties which suffered most in 1875 have here escaped, as is the case in Missouri, and as is the case in Minnesota with the counties ravaged in the Spring of 1876.

MISSOURI—The counties ravaged by the young insects in 1875, had splendid crops in 1876, and the scarcity which I had anticipated (Rep. 8, pp. 120, 156,) of most noxious insects, including the native locusts and the Chinch Bug, was everywhere noticed and commented upon. The incoming of the winged insects in the Fall was anticipated and feared, as soon as it was known that they were overruning Nebraska and Western Iowa. Feeling the importance of obtaining exact data as to the territory invaded in our own State, and in which eggs were laid, in order to indicate just where injury may be expected, or not, next Spring; I have taken pains to examine, or get reports from, all the western counties. These reports, in condensed form, are herewith submitted; and, summarized, they show that the middle western counties, which suffered most in 1875, (i. e., the portion of the State in which the winged insects reached farthest east in 1874, and laid most eggs) were not overrun in 1876, and will not suffer next Spring. Such are the counties of Platte, Clay, Jackson, Lafayette, Cass, Johnson, Bates, Henry, Pettis and Benton. In these counties the farmers have little or nothing to fear, except as they may receive a few straggling and comparatively harmless bevies of the winged locusts next June and July, from the neighboring country. The counties that were overrun and that will suffer are: 1st, Atchison and Holt, and the western half of Nodaway and Andrew, in the extreme northwest corner. 2d, McDonald, Barry, Jasper, Lawrence, Barton, Dade, Newton, Cedar, Vernon, more particularly in the southwest half; Polk in the northwest third; Hickory in the southwest third; St. Clair in scattering places, and Christian and Greene in the extreme border.

The locusts came into all these counties last Fall, very generally ate off the Fall wheat, and filled the ground with their eggs, in most parts quite thickly. As elsewhere, they continued laying till overtaken by frost.

Bates, according to one correspondent, also received a few of the insects in the western half; while a few stragglers are also reported in Harrison, and even in Gentry, Henry and Cass; but it is evident that in these cases they were not in sufficient numbers to do harm or to cause any forebodings for the Spring. They came into the N. W. corner from the N. and N. W., early in September* and were to some extent prevented from reaching beyond the points indicated, by south winds.

They entered the S. W. counties from the S. W. nearly a month later, invading Newton and McDonald by September 23, and reaching the middle of Barry by the first of October, and Cedar by the middle of this month. It is quite clear that the eastern limit of the swarms which came from the N. and N. W. was receding westward after they reached N. W. Missouri, and that S. W. Missouri, S. E. Kansas and N. W. Arkansas would have escaped had it not been for W. and S. W. winds that brought back insects which had reached south of these points.

The dates of arrival of the insects are nearly a month later than in 1874, and in this respect the 1876 invasion more nearly resembles that of 1866. It was also less immediately disastrous than that of 1874, and most crops were either garnered or beyond injury, and the principal damage was to the Fall wheat, which, as already stated, was eaten down, and in most cases effectually destroyed, at a time, too, when it was generally too late to do anything more than let the ground lie over to plant in corn in Spring.

Various correspondents note that all the holes made by the female were found to contain no eggs when examined, and they argue therefrom that few or no eggs have been laid. From what I said two years ago (Rep. 7, p. 123), and from the philosophy of the process of egg-laying (given further on), it follows that such reasoning is fallacious,

*According to Signal Service Reports some were seen in Nodaway county much earlier.

for all holes left by the female are more or less completely empty, since whenever oviposition has taken place, the hole is filled up.

Locusts, or "grasshoppers," were reported as quite troublesome in Ste. Genevieve and other eastern counties, but they were invariably the common Red-legged species (*femur-rubrum*).

Andrew Co.—If you draw a line about five or six miles west of the One Hundred and Two River and Savannah, about due north and south, it will show the extreme eastern boundary of the locust this year in this county. It will show you, at its northern extremity, a strip of about eight miles east of the Nodaway River infested; while at its southern point it will be only about two miles. A great many eggs are there deposited, but not so many as were left two years ago; nor is there so much alarm felt now as then. The locusts arrived late, yet in time to eat up Fall wheat before the frost arrested their progress. Where I live—four miles east of Bolckow—there were no locusts and no eggs, and we do not feel much alarm for next year.
BOLCKOW, MO., Nov. 26, 1876. R. H. TALBOT.

The locusts visited this county in the Fall, but only the western part. It was late in the Fall when they came. They laid some eggs, but they did no great damage.
WHITESVILLE, MO , Dec. 1, 1876. J. F. SMITH.

The locusts flew into Andrew county in large numbers. They did not go farther east than the center of the county; but in the northwest and western parts they deposited their eggs in great numbers, and the prospect is that next year the supply will exceed the demand. JOHN K. WHITE.
FLAG SPRINGS, MO., Dec. 9, 1876.

The grasshoppers were in the northwest part of this county and did some damage to wheat crops. They deposited some eggs. Injury from them in the Fall was small. J. KIMBERTIN.
ROCHESTER, MO , Dec. 18, 1876.

Atchison Co.—The locusts commenced to drop here the first day of September, coming from the north with the first north wind we had for some time, and commenced depositing their eggs on the fourth, staying with us till the wind got in the north again, when many would leave every clear morning, but only to be replaced in the evening by others. Though their numbers have greatly diminished in the last few days, timothy meadows, pastures, gardens and all available places are full of eggs, in many instances from three to five thousand to the square foot; Fall wheat and turnips are eaten off close to the ground, and what timothy is not already destroyed, will surely be in the Spring when the eggs hatch. C. E. TREADWELL
ROCKPORT, MO., Sept. 10, 1876.

[Dispatches from various parts of the county show that during the early part of September the insects continually came from the N. W., but poured down in increased numbers on the 11th. By the middle of October the unusually warm weather had about that time caused many of the eggs to hatch.]

The Rocky Mountain Locusts came upon us in September and October. The only damage done by them was to the Fall wheat and rye. They covered the entire county, so far as I could ascertain, depositing their eggs all over it. When they commenced laying, the ground was wet, and they did not appear (as far as my observation extended) to deposit as many eggs as heretofore in their cells—not over half of them having eggs in, and even these being seldom more than half filled. I have heard of some of the eggs hatching out late in the season, but saw nothing of the kind myself. I made examinations some time in the latter part of October, and found what appeared to be the common maggot in the cells, the eggs in the same having the appearance of being spoiled, many being addled or entirely without substance in the shell. There is considerable anxiety among our farmers, as well as in the community generally, as to what they will do the coming season. Much could be done, in my opinion, by concerted action in the early Spring months, in destroying the eggs and the "hoppers" as soon as hatched. If half the time given to grumbling and loafing, in this community, had been spent in active efforts against the "hoppers," in past seasons, and had such efforts been general throughout the grasshopper regions, an immense amount might have been saved to the country. JOHN D. DOPF.
ROCKPORT, MO., Dec. 3, 1876.

Barry Co.—The grasshoppers came into this county about the first of October,

from the west, and extended to the eastern border. As far as they came east they laid eggs. They worked on the wheat-fields. W. F. TUTTLE.
GOLDEN, MO., Dec. 3, 1876.

Barton Co.—The Rocky Mountain Locust made its appearance in this county about the 25th of September last, coming from the south and southwest. They have destroyed the wheat in the southern and western portions of the county, but have not done so much damage north or east. They laid a great many eggs, some of which hatched out before the cold spell we have lately had. A. A. DYE.
LAMAR, MO., Nov. 26, 1876.

I take the earliest opportunity of giving the limited information I am in possession of. The grasshoppers came into the northeast portion of Barton county in small numbers on the 2d of October, from the southwest; and again, in large numbers on the 13th, from the south. They destroyed all the late wheat, but deposited few eggs.
DOYLESPORT, MO., Dec. 9, 1876. J. J. BRYNING.

The grasshoppers did visit our county last Fall. They came from the west, or, perhaps, from the southwest. Came into the western part of the county in destructive numbers about October 20th, arriving at Lamar about two weeks later.

In the southwestern corner of this county the wheat is all, or nearly all, destroyed. In the northwestern corner, early sowed wheat is from one-third to one-half remaining—late sowed wheat is all gone. At Lamar, the destruction is less. In the S. E. corner of the county wheat was much injured. In the N. E. corner wheat was not injured at all. They remained where they first lit down until frozen up in sleet and snow. Large pieces of wheat are less injured than small ones, as the hoppers commenced on the edges and worked toward the center. Farmers could not sow over, as the hoppers remained until cold weather. It is impossible to say how much of the wheat that was eaten off will recover, as the ground froze up and wheat stopped growing as soon as the hoppers died. We *know*, however, that the wheat at the edges is killed, but we cannot tell before growing weather how far in it is killed. I have two large pieces, containing 91 acres, in N. W. corner of county, that I *believe* one-third remains uninjured; while a 13-acre piece, 110 rods long, I *believe* is *all* gone. I believe that most farmers are preparing to sow oats early in the Spring around the edges of their wheat fields, and it is hoped that this course will destroy the eggs. There were comparatively few eggs deposited. WM. H. AVERY.
LAMAR, MO., Dec. 22, 1876.

Bates Co.—No part of this county was visited by the locusts this Fall. The southern part of Vernon was; also, all Barton, Jasper, Newton, McDonald and the western parts of most counties immediately east of those named. They deposited their eggs in all parts visited. G. B. HICKMAN.
MULBERRY, MO., Dec. 14, 1876.

[Addie Haynes, of Rockville, and others, report them to some extent in the western half of the county, and some eggs laid as far east as Butler.]

We have not had, so far as my knowledge extends, any Rocky Mountain Locusts the past season in our county. Our people sowed last Fall a larger number of acres of wheat than they had put in for the previous three years, and all the wheat fields, up to the present time, look very promising for a good crop. CHAS. J. ROBORDS.
HUDSON, MO., Jan. 3, 1877.

Benton Co.—No locusts came into Benton county this Fall.
WARSAW, MO., Nov. 29, 1876. JAMES H. LAY.

The locusts did not, to my knowledge, visit this county in the Fall. If they did at all, it was in the northwest part, and very few. J. H. MAXWELL.
MT. VIEW, MO., Dec. 16, 1876.

Buchanan Co.—No "hoppers" visited any part of this county last Fall, nor do I think they came nearer than twenty miles west of it. M. W. FARRIS.
AGENCY, MO., Nov. 28, 1876.

Cass Co.—There were no locusts in the county during the year.
AUSTIN, Nov. 30, 1876. H. L. HEWITT.

There have been no locusts in this county the present year, for which all good citizens are truly grateful. WM. A. SMITH.
EAST LYNNE, MO, Dec. 3, 1876.

There were a few scattered grasshoppers in this county during the Fall, but I am not sure they were of the Rocky Mountain species. They did no damage and laid no eggs. In fact, depredating insects were remarkably scarce this Fall, except the Flat-headed Apple-tree Borer, which was more numerous than usual.
RAYMORE, MO, Dec. 4, 1876. W. H. BARRON.

A few Rocky Mountain Locusts alighted in the southern border of Cass county, and also in our neighborhood, near Harrisonville; but very few. This was about the end of October and beginning of November. I don't think they laid any eggs in this county; I have seen no signs of them. On the 5th, 6th and 7th of November, I was in the southwestern part of Bates county, and there I saw more of them. I saw that the young wheat was eaten off, and, after hunting a little, I found them huddled in under the blades of the wheat.

Their general course of flying was southeast, and I think it was too late in the season for them to deposit any eggs. DAVID DEFAKAUGH.
RAYMORE, MO., Dec. 18, 1876.

Cedar Co.—The grasshoppers came to this county in October, and remained until the snow came and destroyed them. They laid eggs all the time they were here, and ate all the wheat in the county. G. W. MONTGOMERY.
STOCKTON, MO., Dec. 2, 1876.

The locusts arrived here about the 16th of October, and began at once to bore into the ground and deposit their eggs. They chose the hardest ground they could find, seeming to prefer that which was sandy or gravelly. They continued coming for two weeks, and would average one to every square foot of the whole ground. They devoured about nine-tenths of the wheat in this, the south part of the county. They came from the southwest. W. SMILEY.
STOCKTON, MO., Dec. 2, 1876.

Locusts were here in vast numbers, laying eggs and destroying nearly all the wheat. C. W. JORDAN.
WHITEHARE, MO., Dec. 9, 1876.

Caldwell Co.—No injury from locusts in this county, and no eggs laid.
GOULD FARM, MO., Dec. 23, 1876. C. L. GOULD.

Clay Co.—No part of our county was visited by locusts the past season.
HARLEM, MO., Nov. 30, 1876. J. C. EVANS.

The Rocky Mountain Locusts did not make their appearance in this vicinity at any time during the year 1876. An occasional straggler could be seen during September and October. None but close observers noticed them. DAN. CARPENTER.
BARRY, MO., Nov. 30, 1876.

Dade Co.—The locusts came the first week in October in sufficient force to destroy about all of our Fall wheat. They laid eggs, which, in dry spots, hatched out, and the young hoppers have been killed by the frost. R. A. WORKMAN.
GREENFIELD, MO., Dec. 11. 1876.

DeKalb Co.—DeKalb county has not been visited by the Rocky Mountain Locust this year. G. E. SHULZ.
HAVANA, MO., Dec. 2, 1876.

Gentry Co.—A few scattered grasshoppers were seen passing over the county this Fall, but none stayed. They were flying very high in air, and to the southwest.
MT. PLEASANT, MO., Dec. 3, 1876. CHARLES S. WHITESCARVER.

One flight of locusts passed over this county. Wind from the N. W. A few stayed here. No deposit of eggs.
GENTRYVILLE, MO., Dec. 16, 1876. HUGH STEVENSON.

There were a few Rocky Mountain Locusts along the western part of the county, but they stayed only a few days, and deposited no eggs. LEVI LONG.
ISLAND CITY, MO., Dec. 29, 1876.

Greene Co.—There were no hoppers in Greene county, except in the S. W. corner, where they came too late to do much harm. Some passed over to Christian Co. and did some injury. In Lawrence Co., also, they did considerable mischief.
SPRINGFIELD, MO., Dec. 23, 1876. F. F. FINE.

Harrison Co.—Only a few straggling grasshoppers fell into this county the past season; they deposited no eggs. Their nearest approach, in large numbers, was about 40 miles west of us. JOSEPH WHITELEY.
NEW CASTLE, MO., Dec. 4, 1876.

There has not been any locusts or grasshoppers in this county this fall.
EAGLEVILLE, MO., Dec. 4, 1876. COL. H. FITCH.

There were no locusts in either Harrison or Mercer counties the past year.
CAINSVILLE, MO., Dec. 1, 1876. J. H. BURROWS.

Henry Co.—The locusts did not get to our county this year. They reached the counties South and West of us. We have a few, remaining from a year ago, that seem to be acclimated, and they are enough, with our native hoppers, to eat considerable wheat; but the weather is good for their destruction this Fall. T. J. QUICK.
GAINES, MO.

A few Rocky Mountain Locusts came to this, the eastern part of Henry Co.; but I have seen none, neither have I heard of any depositing their eggs.
LEESVILLE, MO., Dec. 12, 1876. J. E. STRINGER.

Hickory Co.—The locust came into the southwest part of this county in the latter part of September. They did little or no damage, as they came in late, and were but few in number. I do not believe they laid any eggs here. Our native locusts, this Summer, were fewer than I have ever seen them, and I have lived on a farm in Missouri since 1849. W. L. SNIDOW.
ELKTON, MO., Dec. 7, 1876.

Not any part of Hickory county was visited by the grasshoppers, nor any part of this (Cass Co.) They have been South of us in Vernon, Cedar, Polk and parts of St. Clair counties, depositing eggs. C. J. HOSTETTER.
EAST LYNNE, Cass Co., MO.

Holt Co.—The grasshoppers (*Caloptenus spretus*) commenced their flight over us to-day at 12 o'clock M., going in a southeasterly direction. Wind is blowing from the North, which is very favorable for them in their journey this way. They are not in very great numbers as yet; but are reported as being in immense numbers in the North part of the county. J. W. MAPLE.
OREGON, MO., Sept. 8, 1876.

The *spretus* are daily increasing in numbers here, taking all the wheat and rye sown in the county. They are depositing eggs. To-day they are going N. W. Wind South. J. W. MAPLE.
OREGON, MO., Sept. 26, 1876.

The pests are still with us, and are now depositing their eggs by the million. Some report that a small white worm is killing them, but I have been unable to find any up to this time. Some of the eggs are now hatching in North parts of the county.
OREGON, MO., Oct. 12, 1876. J. W. MAPLE.

Many of the grasshopper eggs have been destroyed by a small white worm, and many have been washed out and destroyed by exposure to the weather. The grasshopper limits extend about 5 miles east of the Nodaway River, in Andrew Co.
OREGON, MO., Dec. 2, 1876. J. W. MAPLE.

The locusts have spread all over this county, and have deposited their eggs in vast quantities, though perhaps less than in '74. I examined many of their perforations, and in some localities found at least three-fourths empty; in the others, from 12 to 20 eggs. A few passed over here the 25th of August, and occassionally thereafter, until the 20th September, when they came in large numbers. They had destroyed, by the 25th of September nearly all the wheat and rye in the county. On the 26th they were first noticed laying eggs here. A few were noticed on the 11th of November, some on the ground, others flying North. Many farmers have resown their devastated fields, and will no doubt profit by so doing. Some say that worms and bugs have been destroying the eggs, also that the eggs have been hatching out in exposed places. The experience of some of our farmers is against turning the eggs under in the Fall or Spring.

OREGON, MO., Nov. 29, 1876. WM. KAUCHER.

The grasshoppers were all over this county, and laid more eggs than they did two years ago, the ground being literally filled with them.

BIGELOW, MO., Dec. 2, 1876. J. H. CROW.

From examination made in various parts of the county by several farmers and others, the eggs of the locusts seem to be rotted. This is ascribed to the wet weather, we had some few weeks ago. CLARKE IRVINE.

OREGON, MO., Dec. 3, 1876.

The Rocky Mountain locusts came here last Fall in September; they came from the North, and deposited their eggs in great quantities; some stayed till cold weather killed them, and some wenton South. Some say their eggs have turned to worms and will not hatch, which might be the case, for I noticed, myself, some worms in the cells, but whether they were deposited by the hoppers, or not, I am unable to say.

FORREST CITY, MO., Dec. 18, 1876. J. D. WHITE.

The locusts extended all over our county. They came from the N. W. about September 20th. The ground is fuller of eggs than ever before. All the wheat was taken up; rye also. A few resowed, but it makes no show. They stayed here until frozen to death. BENNET KING.

OREGON, MO, Dec. 25, 1876.

Jasper Co.—The grasshoppers or locusts came here October 2d, and again on the 3d, 5th, 8th and 9th. Ten years ago they reached three miles east of here, now, they are several miles still further east. No doubt in a week the wheat will be all destroyed, as, indeed, most of it is already. They came from the southwest. Wind south. They did no damage here in the Springs of 1867 and 1875. THOS. McNALLIE.

SARCOXIE, MO., Oct. 14, 1876.

The grasshoppers made their appearance in this county again on the 2d of October. The wind was blowing from the southwest during the day. About noon they came into the city; the sky was darkened with them. They soon covered the entire county, and at once began their onslaught upon the wheat fields. Jasper county farmers had put in more wheat than they had ever done before; the season being favorable, it was making rapid growth, and the future looked encouraging with promises of a large wheat crop. In a few days, scarcely a spear of wheat was to be seen over the entire county. However, at the close of November they began to leave; and large quantities of them were found dead; many seeming to have been destroyed by an insect. They deposited eggs, some of which hatched out during the warm days in November. In some of the late sown fields the wheat seems to be starting again; and some farmers have resown portions of their fields, in the hope that a favorable Winter will secure a crop. The eastern line seems to have extended to the west of Green county. JOSIAH TILDEN.

CARTHAGE, MO, Nov. 20, 1876.

On the 2d of October the grasshoppers made their first appearance here, coming from southwest and going northeast, in such numbers as to, in a measure, obscure the sun's rays. They stayed here in millions, until killed by cold; eating up all growing wheat and green grass. The ground was perforated in all directions with innumerable holes, and I suppose they deposited eggs in great abundance. We are in the eastern part of the county, a few miles from the Lawrence county line.

REEDS, MO., Dec. 8, 1876. J. M. THORNBURG.

Myriads of grasshoppers were passing over Granby, from southwest to northeast, on Sunday and Monday, the 8th and 9th. A glance upward towards the sun revealed them filling the air as far as vision could extend, as thick as snowflakes in a storm, and they drifted along with the breeze, and fluttered down at your feet occasionally, or lit on your nose, with as much unconcern as if they had been a part of the elements. The bushes and sides of the road were speedily thick with them.—*St. Louis Republican*, Oct. 1, 1876.

The locusts were all over the county in great numbers. They laid a great many eggs, but as most of them hatched out this Fall, I apprehend no trouble next Spring. They came in September, and stayed until killed by frost. No wheat recovered, as far as I know. Farmers generally resowed, but the wheat has not come up.
SMITHFIELD, MO, Dec. 26, 1876. WM. G. L. CRIAG.

The wheat that was eaten off did not recover. Very few farmers have resown. There will be no wheat crop in this and adjoining counties this year. Next Fall there will not be much sown on account of scarcity of seed, and dread of the hopper. Some farmers are contemplating a crop of oats on their wheat ground; others, flax and barley. J. M. PETERSON.
January 2, 1877.

Jackson Co.—There were no Rocky Mountain locusts in this county the past Fall, and, per consequence, no eggs deposited. Chinch bugs were seen in the early Fall.
HICKMAN MILLS, MO., Dec. 4, 1876. W. S. PARRISH.

The grasshoppers did not deposit any eggs here; only a few straggling ones, and they perhaps of native species made their appearance. JACOB GREGG.
STONY POINT, MO., Dec. 10, 1876.

Johnson Co.—The Rocky Mountain locust failed to visit us the past season. A few were noticed very high in the air, passing over with the wind, but none alighted. We have no chinch bugs at all this season, owing, perhaps, to the fact that the small grain was totally destroyed by the hoppers in 1875. But such other pests as usually trouble us were very numerous and destructive. D. B. REAVIS.
KINGSVILLE, MO., Dec. 4, 1876.

No grasshoppers came here this season. They appeared in Barton county in October, though not in great numbers, and west of that county, in Kansas, for a hundred miles, they were very numerous, and depositing their eggs, at the end of September. W. A. CAMPBELL.
HOLDEN, MO, Nov. 27, 1876.

There were no grasshoppers in our county this Fall. There may have been some at the southwest corner of the county, but I do not think so.
WARRENSBURG, MO., Dec. 8, 1876. J. L. CLELAND.

FAYETTEVILLE—None. J. L. MOTSINGER.

Lafayette Co—Lafayette county has not been visited this year by the Rocky Mountain locust. J. BELT.
LEXINGTON, MO.

No locusts came into this county the past season, or into Jackson county either.
SNI-A-BAR, MO., 1876. J. T. FERGUSON.

Lafayette Co.—There were a few of the genuine Rocky Mountain locusts with us during the latter part of September, and beginning of October; but they were so few in number as to pass almost unnoticed, and were supposed to be stragglers, from a flight that passed down through Kansas, depositing a vast number of eggs as far South as Montgomery county, in that State. If those that were in this county laid any eggs, they were so few as not to be observed, and it is my opinion that none were deposited. As to what part of the county was invaded, it would be hard to tell, as they were so few in number; and the fact that they mix up with the natives, adds to the difficulty.
AULLSVILLE, MO., December 10, 1876. JAS. E. GLADISH.

Lawrence Co.—The locusts came into this county about the 5th of October. Their course was North. A small portion of the southeast part of the county was not visited by them, and there the wheat crops are not hurt; but they spread over all other parts,

eating up thousands of acres of wheat. Some farmers have resown, but many have not. They deposited their eggs by the acre, choosing, strange to say, the hardest and most gravelly places to lay them in. I found, on examination, just at the setting in of Winter, that very many of the eggs had so far advanced as to resemble small white maggots. The hoppers have penetrated considerably farther East this year in this county than they have ever done before. W. S. GOODMAN.
MT. VERNON, MO., December 12, 1876.

McDonald Co.—The Rocky Mountain locust visited all parts of McDonald county, and deposited their eggs very liberally, some of which hatched out before the cold set in. W. D. POLSON.

Newton Co.—First saw the grasshopper here on September 29. On Sunday the sky was full of them, going East. From here to Joplin they are everywhere; to-day the ground is covered, and the air filled with them. They are at Granby. Farmers are afraid to sow wheat. G. C. BROADHEAD.
NEOSHO, MO., October 7, 1876.

Grasshoppers came into the west part of this county in large numbers on the 23d of September, and soon extended all over it. They came from Northwest at first, but soon they came from all parts, as the wind blew. They would rise and fly off in the fore part of the day, and a new lot would come in at night. They continued very numerous till the sleet storm in November, which killed them; and they filled the ground with eggs; some of which hatched out, and some were destroyed, but plenty yet remain. JOHN THRASHER.
NEOSHO, MO., December 7, 1876.

The locusts came into all parts of this county in vast swarms, and laid large quantities of eggs; every batch of land that was bare, and not too hard, is filled with them, and some few have hatched out this Fall. W. H. WETHERELL.
SENECA, MO., December 6, 1876.

Nodaway Co.—The Grasshoppers came into this county from the Northwest on 11th of September, and left, going southwest, on the 26th of October. They spread over about two-thirds of the county, but the northeast they did not reach, and that part remained uninjured. They deposited eggs, but not so many as was expected from their numbers. Many fields of wheat in the western part of the county were entirely destroyed. The greatest damage was done to fall grain and meadows.
PICKERING, MO. M. B. W. HARMAN.

The locust came into the west or northwest portion of our county late in the Fall. In the extreme West they laid eggs, and devoured the Fall wheat.
LUTESTON, MO., December 14, 1876. WM. H. CLARK.

The grasshoppers were in the northern and western portions of this county last Fall, but did little damage. They laid eggs, but opinions differ as to the probability of their hatching out next Spring. Many contend that some kind of insect has destroyed them, as, repeatedly, when the holes in which they were deposited were dug into, no eggs were found. T. D. WALLACE.
HOPKINS, MO., December 3, 1876.

Pettis Co.—A few grasshoppers came into this county last Fall, but I do not think they laid any eggs. They did no damage. J. K. P. IDOL, M. D.
HOUSTONIA, MO., November 30, 1876.

The Rocky Mountain Locust did not visit any part of Pettis county during the year 1876. O. A. CRANDALL.
SEDALIA, MO., December 11, 1876.

Platte Co.—No locusts here this year. Sixty miles north and west is as near as they came to us. JAMES ADKINS.
PLATTE CITY, MO., Dec. 1, 1876.

No locusts in our county this Fall; a few are reported to have fallen from a great height, carried out of their course by adverse winds. R. P. C. WILSON.
PLATTE CITY, Mo, December 1, 1876.

Polk Co.—The locusts came into our county last Fall at a late date. They did not get so far East as this in large quantities; but at the western border of the county they were numerous, though I have been unable to ascertain whether or not they deposited any eggs; but they came so late that I hardly think they did. T. W. WILSON.
PAYNE'S PRAIRIE, Mo., December 18, 1876.

In the three western townships of this county the hoppers have damaged the wheat badly, and have deposited large numbers of eggs, They have been very destructive in the eastern part of Dade and Cedar county. J. CARSON.
BOLIVAR, Mo, December 15, 1876.

No wheat was eaten off in this immediate vicinity. I do not think any attempt was made to resow; the damage was done too late. I hear of no measures being taken to protect wheat or other grain from the threatened ravages. T. W. SIMPSON.
PAYNE'S PRAIRIE, Mo., December 30, 1876.

The locusts visited the western portion of this county some time last Fall, in October or November, I believe, and did considerable damage to a few fields of young wheat; though I think they were found only in a few isolated spots. Don't know whether they laid eggs or not. H. CARR PRITCHETT.
MORRISVILLE, Mo., January 6, 1877.

The locusts visited the western townships of our county, Jackson, Madison, and Johnson. They made their appearance between the 1st and 10th of October, and came from the West. They filled the ground with eggs. Where most numerous they entirely destroyed the growing wheat. J. M. LOAFMAN, M. D.
MORRISVILLE, Mo., December 27, 1876.

Ray Co.—No part of our county was visited by the Rocky Mountain locusts during the year. W. R. MEADOR.
HARDIN, Mo., December 29, 1876.

St. Clair Co.—The locusts dropped in here in very small numbers late in October. The wind was from the north as they were coming in, and carried the greater part to Texas; only those that had tired out staying with us. They laid eggs, and injured the wheat somewhat. I hear that they have eaten all the wheat from Sac River south to Arkansas. It is very cold just now, and no hoppers visible.
COLLINS, Mo., Dec. 2, 1876. WM. H. FILLERY.

But very few Rocky Mountain Locusts came into the county this year. None to do any damage to crops. South of us, in Barton, part of Cedar and Polk counties, they are reported to have destroyed the wheat crops in places. JOHN HILL.
TABORVILLE, Mo., Dec. 6, 1876.

Vernon Co.—The locusts visited the southwestern portion of our county this Fall, doing much damage to wheat. They deposited a vast number of eggs, yet the deposits were not so numerous in proportion to the number of insects as in former years—say fifty per cent. M. L. MODREL.
LITTLE OSAGE, Mo., Dec. 9, 1876.

They came into the south and west half of Vernon in great numbers, and, it is said, deposited eggs as usual. Very few appeared in the northeast part, and no eggs deposited there. J. A. PURINTON.
SCHELL CITY, Mo., Dec. 2, 1876.

No damage sustained in northeast part of this county. But few made their appearance. In the Spring of 1875, the young appeared in immense numbers, but unaccountably disappeared from this locality before half grown, and did no damage.
SCHELL CITY, Mo., Dec. 23, 1876. J. A. PURINTON.

The grasshoppers destroyed every field of wheat with which they came in contact, beyond recovery. On account of the lateness of the season farmers are letting their wheat lands lay over for corn, in the Spring. M. L. MODREL.

LITTLE OSAGE, Mo., Jan. 8, 1877.

INDIAN TERRITORY.—They were thick over most of the Territory, passing southward, from the middle of September, and many of them remaining through the season. They rendered horse-back travel extremely unpleasant.

TEXAS—The swarms reached Texas from the North and West about the middle of September, and from that time forth till Winter were flying very generally, over the State, reaching eventually latitude 29°, or more definitely to the Gulf all the way from the Sabine river to Austin. Their course was almost due South, and their injury confined to succulent vegetables, shrubs and fruit trees, the Orange and Cotton suffering more particularly.

Mrs. H. S. King, of Austin, writes:

The cars for about ten days were so much obstructed on the Texas Central line as to necessitate their stopping occassionally to clear the track of the grasshoppers. Though there were millions, they were never sufficiently numerous to obscure the sun, even for an instant, and they have been, as they usually are at this season, comparatively harmless to vegetation. For about six weeks they would fly up in the promonaders' face like a pelting rain, alighting on the head and clothes, or taking short flights in advance of him.

They were especially thick on walls, fencetops, and tree trunks, remaining there torpid until the sun shone out, and during the heat of the day swarming high in air, when they look like snow-flakes, wafted by changing breezes.

Messrs. Nelson and Sadler, of Galveston, state that the insects occurred all along the line of the Texas Central Railroad. It was most noticeable, as Mr. Jno. M. Crockett, of Dallas, assures me, that notwithstanding the wind was, on the 19th September, and for a few days thereafter, when the heaviest flights occurred, from N., N. E.; it yet varied much during the invasion, blowing mainly from the S. E. Nevertheless the insects made steady progress southward, succeeding best on calm days and not diverging E. five miles in fifty. Contrary winds simply baffled them and brought them to the ground until the conditions permitted them to continue their course.

Eggs were laid throughout the territory overrun, and the young hatched in large quantities during the mild weather of February. Up to the time this writing goes into the printer's hands, (March 5, 1877), the young, which have numerously hatched near the Gulf, have been destroyed by heavy cold rains that occurred the latter part of February.

ARKANSAS—The insects overran the extreme N. W. corner of this State, as indicated in my map, and were particularly bad in Benton county. Indeed the injury was mostly confined to this county and the region south of it, the insects not extending east to Carroll county. This is the first recorded instance of their reaching into Arkansas. They made their advent from the 7th to the 15th of October, coming with the wind from the N. W. and flying S. and S. E., until they struck the base of Boston Mountain. As in our own S. W. counties, wheat was greatly injured by them, and eggs were laid up to the time Winter set in.

From the foregoing record, summed up from numerous reports and observations, it is manifest that the locusts that hatched and did more or less damage in Minnesota early in the year, endeavored to get away to the northwest as soon as they got wings. They were subsequently repulsed and borne back again by the winds to their hatching places; thence south and southwest into Iowa and Nebraska. As they rise and fly from day to day they concentrate and condense, since in passing over a given area during the hotter parts of the day new accessions are constantly being made to the flying hosts which, with serried ranks, descend in the afternoon. Thus, in returning, the swarms were thicker and more destructive in places than they were in leaving. Yet it is evident that the column which thus came back to Minnesota and passed to the south and southwest was more straggling than in 1874, and that by the middle of the month it had spent its force and left eggs throughout most of the country traversed. Had the invasion consisted of these only, the damage would have been but slight, and the insects would hardly have reached into Kansas. Their eggs, laid in August, were far more liable to injury and to premature hatching than those laid later. But it is clear that fresh swarms that hatched in Dakato, and further northwest, followed on the heels of the Minnesota swarms, passing over much of the same country to the east and southward into Colorado, and eventually overruning the larger part of Nebraska and Kansas, the Western half of Iowa and some of the Western counties in Missouri, and reaching into Indian Territory, Texas and parts of Arkansas.

The extent of the region invaded will appear by referring to the map (Fig. 16). Coming generally later than in 1874, they did less damage, and the farmers were in so much better condition to withstand injury, that it was much less felt. In most sections visited, part of the migrating hosts remained to lay eggs; and the invasion of 1876 is remarkable as compared to that of 1874, for the large extent of country supplied with eggs. Another fact is notable, viz: that the very parts of Minnesota in which eggs were laid in 1875, and the portions of Missouri and Kansas in which they were most thickly laid in 1874, escaped in 1876. I cannot believe, however, that this is anything more than coincidence.

DESTINATION OF THE DEPARTING SWARMS OF 1875.

In considering this subject a year ago, I expressed the belief—founded on observation and the records as far as made—that the swarms which left the country south of the 44th parallel and the 100th meridian passed to the N. W., reaching into N. W. Dakota, Wyoming and Montana. I was unable at the time to state whether or not they reached up into British America, and from the large per centage of the departing insects that were diseased and that dropped on the way, I was led to the following conclusions:

We may very justly conclude that a large proportion of the insects which departed from the country invaded in 1874, perished on their way toward the native habitat of the species, and that those which did not perish reached the Rocky Mountain region of the Northwest whence their parents had come the previous year. They struggled back with thinned and weakened ranks, and it will probably take many years ere they become so prodigiously multiplied again, and are enabled by favorable conditions to push so far east as they did in the year 1874. They did some harm at their resting places on the way, but in a large number of instances they rose after their brief halts, without doing serious injury. Nor can I learn of any instances where these swarms that left our territory deposited eggs. Had the winds been adverse to their northwestern course, and obliged them to remain in the country where they hatched, I believe that the bulk, if not all of them, would, nevertheless, have perished before laying eggs.—[Rep. 8, p. 108.

Information gathered during the past year shows conclusively that the insects which left the Mississippi Valley in 1875 did reach into British America. The *Winnepeg Standard* of August 19, 1876, as quoted by Professor Whitman, says:

The locusts which hatched in Missouri, Kansas and Nebraska, in an area of 250 miles from east to west, and 300 miles from north to south, took flight in June, and invariably went northwest, and fell in innumerable swarms upon the regions of British America, adjoining Forts Pelly, Carlton and Ellice, covering an area as large as that they vacated on the Missouri River. They were reinforced by the retiring column from Manitoba, and it seemed to be hoping against hope that the new swarms of 1876 would not again descend upon the settlements in the Red River valley. Intelligence was received here that the insects took flight from the vicinity of Fort Pelly on the 10th of July, and then followed a fortnight of intense suspense.

Professor G. M. Dawson, of Montreal, writes: "You may be interested in knowing that the northward flying swarms in 1875 penetrated a considerable distance into the region west of Manitoba, while most of the insects hatching in the latter Province went southeastward when winged, and that large numbers got at least as far east as the Lake of the Woods." In an interesting paper in the *Canadian Naturalist*, on the "Appearance and Migrations of the locusts in Manitoba and the N. W. Territories in the Summer of 1875," Professor Dawson further gives many other valuable records, some of which, as bearing on the question under consideration, I quote entire, as they will hardly bear condensing:

From the reports now received from Manitoba and various portions of the Northwest Territory, and published in abstract with these notes, it would appear that during the Summer of 1875 two distinct elements were concerned in the locust manifestation. First, the insects hatching in the province of Manitoba and surrounding regions, from eggs left by the western and northwestern invading swarms of the previous autumn; second, a distinct foreign host, moving, for the most part, from south to north. The locusts are known to have hatched in great numbers over almost the entire area of Manitoba, and westward at least as far as Fort Ellice on the Assineboine river (long. 101° 20′), and may probably have been produed, at least sporadically, in other portions of the central regions of the plains; though in the Summer of 1874, this district was nearly emptied to recruit the swarms devastating Manitoba and the Western States, and there appears to have been little if any influx to supply their place. Still further west, on the plains along the base of the Rocky Mountains, from the 49th parallel to the Red Deer river, locusts are known to have hatched in considerable numbers—but of these more anon.

Hatching began in Manitoba and adjacent regions in favorable localities as early as May 7th, but does not seem to have become general till about the 15th of the month, and to have continued during the latter part of May and till the 15th of June. * * *

The destruction of crops by the growing insects, in all the settled regions was very great, and in many districts well nigh complete. The exodus of these broods began in the early part of July, but appears to have been most general during the middle and latter part of that month, and first of August. The direction taken on departure was, with very little exception, southeast or south. It is to be remarked, that as there does not seem to have been during this period any remarkable persistency of northwest or northerly winds, the insects must have selected those favoring their intended direction of migration, an instinct which has very generally been observed elsewhere.

* * * * * * * * *

Foreign swarms from the south crossed the 49th parallel with a wide front stretching from the 98th to the 108th meridian, and are quite distinguishable from those produced in the country, from the fact that many of them arrived before the latter were mature. These flights constituted the extreme northern part of the army returning northward and northwestward from the States ravaged in the autumn of 1874. They appeared at Fort Ellice on the 13th of June, and at Qu'Appelle Fort on the 17th of the same month, favored much no doubt by the steady south and southeast winds, which, according to the meteorological register at Winnipeg, prevailed on the 12th of June and for about a week thereafter. After their first appearance, however, their subsequent progress seems to have been comparatively slow, and their advancing border very irregular in outline. They are said to have reached Swan Lake House—the most northern point to which they are known to have attained—about July 10; while Fort Pelly, further west, and nearly a degree further south, was reached July 20th, and about seven days were occupied in the journey from there to Swan River Barracks, a distance of only ten miles.

We thus learn that vast swarms not only reached into British America in 1875, from our own country, but that the young hatched there from swarms that had come the previous year from the further northwest.

There was, therefore, north of the 49th parallel, a repetition of the devastation we were at the time experiencing; the insects hatching there in bulk just about the time they were leaving Texas on the wing.

SOURCE OF THE SWARMS OF 1876.

From the preceding statement of facts, and from the detailed history of the invasion of 1876, it becomes obvious that this invasion was made up, 1st, of such insects as hatched out in southwest Minnesota, and parts of Colorado, Wyoming and Dakota; 2d, of additions to these from Montana and British America. In how far those in either of these categories were made up of the progeny from the insects that left our country in 1875 we shall never be able accurately to determine. The proportion of parasitized and diseased insects that left Missouri, doubtless became less among those which hatched and rose from the farther north and west, and we may, I think, take it for granted that the larger part of the swarms that reached Montana and British America, laid eggs. In addition to the vast bevies which invaded the northwest from the south and southeast, there were in 1875, as Prof. Dawson shows, others that hatched in the northwest, pouring from British America into our Northwest territory. There were, in fact, in Manitoba, and large parts of the Northwest, two grand opposing movements of the winged insects, which thus replaced each other. And bearing this in mind, we can understand the increased area in the Northwest over which eggs were laid that year, and from which the 1876 swarms had their source. As no eggs were laid in Manitoba, while the young are known to have abounded in the mountain region to the west of that province, it is more than probable that the principal source of the 1876 invasion was Montana and the Saskatchawan and Swan River countries. The question as to how far the northwest breeding grounds are recruited by the insects which hatch in the more fertile country which I have designated as outside the species' natural habitat, is a most interesting one; for if thus recruited there is all the greater incentive for us to exterminate the young insects which hatch with us. All such questions can only be settled by a thorough study of the subject by a properly constituted commission, charged by Congress with the work.

EASTERN LINE REACHED.

A study of the eastern limit of the invasion of 1876, compared with that of 1874, shows that it is peculiar in reaching farther east in Minnesota and Iowa, and farther south and east in Texas. The limit-line—extending from Clay county, Minnesota; bulging toward St. Paul, reaching southwardly to the center of Iowa; thence westwardly receding to Lawrence, Kansas, and bulging again to Southwest Missouri—is more irregular between the 36th and 46th parallels than it was in 1874. On an average, however, it does not extend east of the 94th meridian.

RATE AT WHICH THE INSECTS SPREAD.

Leaving Montana about the middle of July the insects reached far into Texas by the end of September, thus extending about 1,500 miles in 75 days, or an average of about 20 miles per day. But over a large part of this territory, viz., portions of Wyoming, most of Dakota and Nebraska, W. Minnesota, N. W. Iowa, N. W. Kansas, and N. E. Colorado—they appeared almost simultaneously, or during the last few days of July and the first few day of August; and this, I think, indicates that they were at that time swept down at a very much higher rate by the N. W. winds from Montana and British America. After that time the extension S. was tolerably rapid, but the extension E. was more and more slow. They occupied nearly a month reaching from N. W. Iowa to the S. W. limit in the same State, and their eastward progress on the confines of the limit line already indicated was still more gradual as they went South. All of which indicates that they fly most powerfully when leaving the higher altitudes of the N. W., and most persistently during the first week or so after becoming fledged, while the females are not yet prompted to descend for oviposition. This is also the period when they are passing over the vast plains and the sparsely settled and uncultivated portion of the country, in which there is, perhaps, least inducement for the ravenous host to halt.

As flight is not consecutive day after day, but often impeded by bad weather, and as it is not continuously in one direction, the average rate is not more than 20 miles a day. It is also most variable and at times reaches a maximum of between two and three hundred miles daily.

DIRECTION OF FLIGHT.

The wind was quite changeable during the period of invasion, and we find the insects, at one time or another, traveling in nearly all possible directions, except due west. Yet, if we except the departing swarms which flew from N. W. Minnesota in July, the direction of the invading hosts was, as I believe it always has been and always will be, conspicuously S. and S. E. The exceptions were principally during the first week in August, when they swept S. W. from Minnesota over parts of Iowa and Nebraska; and two months later when they were carried N. E. into our S. W. counties.

INFLUENCE OF THE WIND IN DETERMINING THE COURSE OF LOCUST SWARMS.

That excessive multiplication and hunger are the principal causes of migration from the native home of the species, and that the prevailing winds determine the course therefrom, I have endeavored to show (Reps. 7, p. 104; 8, p. 112). That all these influences very largely determine the return migration when the insects hatch out in the Mississippi Valley is also doubtless true; and it is interesting to note in this connection that, according to observations, covering a period of from two to five years, furnished by General Myer, at the request of Dr. A. S. Packard, Jr.,* the prevailing winds in May and June, within the region subject to invasion, are from the Gulf of Mexico, or from the S. E. and S., *i. e.* in the opposite direction, prevails later in the season. Yet, to assume that the migrations are solely dependent for direction on the winds would be incorrect, as there is cumulative evidence (much of it recorded in these Reports) that when once the migration has commenced, adverse winds only retard, but do not materially change its course.

LOCUST FLIGHTS EAST OF THE MISSISSIPPI.

To the unscientific mind there are few things more difficult of apprehension than that species, whether of plants or animals, should be limited in geographical range to areas not separated from the rest of the country by any very marked barriers, or by visible demarcations. Yet it is a fact well known to every naturalist, and the geo-

* "The Destructive Locust of the West," *Am. Naturalist*, Vol. XI, p. 27.

graphical distribution of species forms at once one of the most interesting and one of the most important studies in natural history. Some species have a very limited, others a very wide range; and while in the course of time—in the lapse of centuries or ages—the limits have altered in the past and will alter in the future, they are, for all practical purposes, permanent in present time. These limits may in fact, for the purpose of illustration, be likened to those which separate different nations. Though frequently divided by purely imaginary lines, the nations of Europe, with their peculiar customs and languages, are well defined.

Along the borders where the nations join, there is sometimes more or less commingling; at other times the line of demarkation is abrupt; and in no case could emigrants from the one, long perpetuate their peculiarities unchanged in the midst of the other. Yet in the battle of nations, the lines have changed, and the map of Europe has often been remodeled. So it is with species. On the borders of the areas not abruptly defined, to which species are limited, there is more or less modification from the typical characters and habits; while in the struggle of species for supremacy, the limits may vary in the course of time. The difference is, that the boundaries of nations result from human rather than natural agencies, while those of species result most from the latter, and are threfore more permanent. These remarks apply of course to species in a natural state and where their range is uninfluenced either directly or indirectly by civilized man.

I found some difficulty at the late Conference of Governors at Omaha to consider the locust problem, in satisfying those present that the Rocky Mountain Locust could not permanently thrive south of the 44th parallel, or east of the 100th meridian, and that there was no danger of its ever extending so as to do serious damage east of a line drawn a little west of the centre of Iowa. They could not see what there was to prevent the pest from overrunning the whole country, and thought that Congress should be appealed to, not only on behalf of the country that has suffered fromits ravages, but on behalf also of the whole country that is threatened therefrom.

Having discussed in my two previous Reports the native home of the species, and the conditions which prevent its permanent settlement in the country to which it is not native, it is unnecessary here to go into detail on these points. Briefly, the species is at home and can come to perfection only in the high and dry regions of the Northwest, where the Winters are long and cold and the Summers short; and whenever it migrates and oversweeps the country to the south or southeast, in which it is not indigenous, the changed conditions are such that the first generation hatched out in that (to it) unnatural climate, either forsakes it on the wing or perishes from debility, disease and general deterioration. On the soundness of this conclusion depends the future welfare of most of the more fertile States between the Mississippi and the mountains, and science, as well as past experience, show it to be sound. Upon this hypothesis the people of nearly the whole country so scourged during the past year, and so threatened next Spring, may console themselves that the evil is but temporary: they may have to fight their tiny foe most desperately next Spring, but they have also the assurance that even if he prove master of the field, he will vacate in time to, in all probability, allow of good crops of some of the staples, and that he may not return again for years. On the other hypothesis—for which there is only apparent, and no real reason—ruin stares them inevitably in the face.

The causes which limit the eastward flight of the winged swarms that come from the Northwest are, with the majority of people, still more difficult to appreciate ; for most persons can see no reason why a swarm that overruns the western portions of Minnesota, Iowa and Missouri, should not extend to the eastern borders of the same States, or into Illinois, Indiana, Ohio and eastward. Having previously considered the more occult climatic influences that bear on the belief that they never will, I need only state here, that the principal arguments rest in the facts that—1st, the power of flight of any insect that has a limited winged existence, must somewhere find a limit; 2d, that all past experience has shown that *Caloptenus spretus* has never extended, in a general way, beyond the limit indicated, and that as long as the present average conditions of wind and climate prevail, it is reasonable to suppose that it never will.

One of the principal difficulties in the way of a proper apprehension of the facts, is found in the failure, in the popular mind, to discriminate between species. The ordinary newspaper writer talks of *the* grasshopper, or *the* locust, as though all over the country and all over the world there was but one and the same species. One of the Governors present at the Conference referred to, was at first fully of the belief that our Rocky Mountain pest came all the way from Asia. In the case of this destructive species, even some entomologists have added to the difficulty by erroneously claiming that it is common all over the country to the Atlantic ocean.

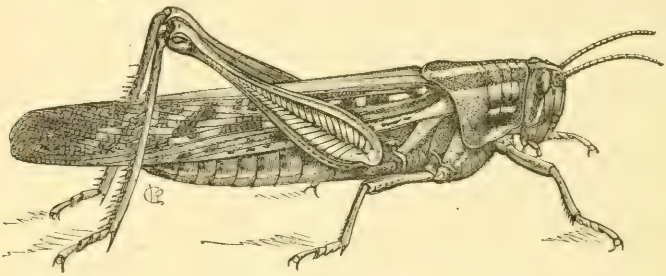
The above thoughts were suggested by the following reports, that met my eye, in the *Cincinnati Gazette* of the 24th of October, from Dayton and Hamilton, respectively, in the State of Ohio:

The advent of Kansas grasshoppers, over Sunday and until Monday evening, in great numbers throughout the city, is a most remarkable incident. They were found early Sunday morning, and left, as suddenly as they came, on Monday evening.

A shower of mammoth grasshoppers came down upon our town and vicinity on Saturday night. We have never seen such large ones before, and we understand from old citizens, that they are entire strangers in this part of the country. We saw a boy have a string tied to two of them (which were as long as a man's finger) trying to drive them, and he succeeded pretty well.

A flock of grasshoppers alighted in Hamilton about 11 o'clock on Saturday night, from the northwest. Those that were not drowned in the river or killed by the heavy rain, were probably gobbled up before Sunday night by the chickens.

[Fig. 17.]



AMERICAN ACRIDIUM.

Such reports as these very naturally confirm the unscientific in the idea that the locust plague of the West, or so-called "Kansas grasshopper," has overstepped the limits entomology ascribes to it, and is upsetting the conclusions which I have come to. The same swarm passed over Oxford in the same State, in a southwesterly direction, and fortunately that veteran and well-known apiarian, the Rev. L. L. Langstroth, who has not forgotten to be a close observer, had specimens sent to me. They proved to be the American Acridium (*Acridium Americanum*). As stated in my 8th Report, this is one of the largest and most elegant of our N. A. locusts, the prevailing color being dark brown, with a pale yellowish line along the middle of the back when the wings are closed. It has a wide range, hibernates in the winged condition, and differs not only in size and habits from the Rocky Mountain Locust, but entomologically is as widely separated from it as a sheep from a cow. It is a species common over the country every year, and during exceptional years becomes excessively numerous and acquires the migratory habit, its wings being long and well adapted to flying. As I learn from Dr. S. Miller of Franklin, it passed in swarms over part of Johnson county, Missouri, late in September; and it was everywhere abundant in 1876.

The following extracts from letters of correspondents refer to this species:

I send you by Mr. Shaw a small package containing specimens of locusts, destructive about Chattanooga and in all eastern Tennessee. They strike me as nearly allied to the Rocky Mountain Locust; fly with the same noise and shine of wings, in large shoals, but are larger.—[Dr. G. Engelmann, Warm Springs, N. C., Aug. 29, 1876.

We have a locust here which has in some places occurred in considerable numbers, and some people think it the same as the one which has produced so much damage in the West. This I doubt, as it is evidently a native species.—[E. M. Pendleton, Prof. of Agriculture, Un. of Ga., Atlanta, Ga., Sept. 14, 1876.

The American Acridium visited us on the night of November 21, (Saturday.) A rain fell during the night. Cambridge City, Indiana, was also visited by them on the same night.—[Herschel I. Fisher, Eastham College, Richmond, Ind.

Toward the end of July the unfledged insects did an immense amount of damage to the cotton and other crops of Georgia and South Carolina. The papers were full of graphic accounts of their destruction, and editors not only very generally took it for granted that they had to do with the western *spretus*, but Mr. T. P. Janes, Commissioner of Agriculture for Georgia, in his circular No. 27, supposed they were the same. Specimens which he subsequently sent me, however, at once revealed their true character.

The damage done by some of the more common locusts that occur over the country, is, let me repeat, sometimes very great, especially during hot, dry years. In some of the New England States their ravages have, in restricted localities, fairly equalled those of the voracious *spretus* of the West. But while a few of them, under exceptional circumstances, develop the migratory habit, they none of them ever have, and in all probability never will, compare to *Caloptenus spretus* in the vastness of its migrations and in its immense power for injury over extensive areas.

Whenever we hear of locust flights east of the Mississippi, we may rest satisfied that they are not of our Rocky Mountain pest, and are comparatively harmless.

DOES THE FEMALE FORM MORE THAN ONE EGG-MASS ?

Whether the female of our Rocky Mountain Locust lays her full supply of eggs at once, and in one and the same hole ; or whether she forms several pods at different periods, are questions often asked, but which have never been fully and definitely answered in entomological works. It is the rule with insects, particularly with the large number of injurious species belonging to the Lepidoptera, that the eggs in the ovaries develop almost simultaneously, and that when oviposition once commences, it is continued uninteruptedly until the supply of eggs is exhausted. Yet there are many notable exceptions to the rule among injurious species, as in the cases of the common Plum Curculio and the Colorado Potato-beetle, which oviposit at stated or irregular intervals during several weeks, or even months. The Rocky Mountain Locust belongs to this last category, and the most casual examination of the ovaries in a female, taken in the act of ovipositing, will show that besides the fully formed eggs then and there being laid, there are other sets, diminishing in size, which are to be laid at future periods. This, I repeat, can be determined by any one who will take the trouble to carefully examine a few females when laying. But just how often, or how many eggs each one lays, is more difficult to determine. With *spretus* I have been able to make comparatively few experiments, but on three different occasions I obtained two pods from single females, laid at intervals of 18, 21 and 26 days respectively. I have, however, made extended experiments with its close congeners, *femur-rubrum* and *Atlanis*, and in two cases, with the former, have obtained four different pods from one female, the laying covering periods of 58 and 62 days, and the total number of eggs laid being 96 in the one case and 110 in the other. A number of both species laid three times, but most of them—owing, perhaps, to their being confined—laid but twice. They couple with the male between each period, and I have no doubt but that, as in most other species of animals, there is great difference in the degree of individual prolificacy.

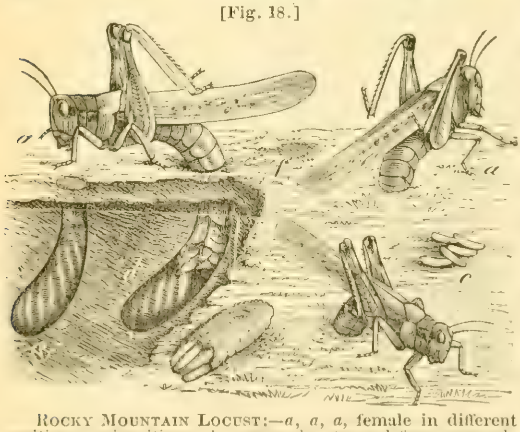
We may, therefore, feel tolerably confident that the Rocky Mountain Locust will sometimes form as many as four egg-pods.

The time required for drilling the hole and completing the pod will vary according to the season and the temperature. During the latter part of October or early in November last year, when there was frost at night and the insects did not rouse from their chilled inactivity until 9 o'clock A. M., the females scarce had time to complete the process during the four or five warmer hours of the day; but with higher temperature not more than from two to three hours would be required.

HOW THE EGGS ARE LAID.

The question as to how best to treat the soil, or to manage the eggs so as to most easily destroy their vitality, is a most important and practical one, and as assisting to a decisive answer, I have carried on a series of experiments, which will be presently detailed. To make the experiments the more intelligible, I will first give the reader a deeper insight into the philosophy of the processes of egg-laying and of hatching than I have hitherto done, and this the more readily that it has never been given by any other author.

[Fig. 18.]



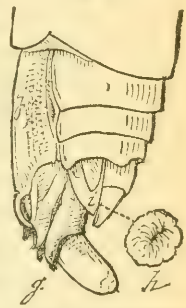
ROCKY MOUNTAIN LOCUST:—*a*, *a*, *a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end broken open; *c*, a few eggs lying loose on the ground; *d*, *e*, shows the earth partially removed, to illustrate an egg-mass already in place, and one being placed; *f*, shows where such a mass has been covered up.

I have already explained (Rep. 7, p. 122) how, by means of the horny valves at the end of her abdomen (Fig. 19) the female drills a cylindrical hole in the ground in which to consign her eggs. The curved abdomen stretches to its utmost for this purpose, and the hole is generally a little curved and is always more or less oblique, (Fig. 18, *e. d.*) If we could manage to watch a female during the arduous work of ovipositing we should find that, when the hole is once drilled, there commences to exude at the dorsal end of the abdomen, from a pair of sponge-like exsertile organs (Fig. 20, *h*) that are normally retracted and hidden beneath the super-anal plate, (Fig. 20, *i*) near the cerci, a frothy, mucous matter, which fills up the bottom of the hole. Then, with the two pairs of valves brought close together, an egg would be seen to slide down the oviduct (*j*) along the ventral end of the abdomen, and, guided by a little finger-like style,* (*g*) pass in between the horny valves (which are admirably constructed, not only for drilling, but for holding and conducting the egg to its appropriate place) and issue at their tips amid the mucous fluid already spoken of. Then follows a period of convulsions, during which more mucous material is elaborated, until the whole end of the body is bathed in it—when another egg passes down and is placed in position. These alternate processes continue until the full complement of eggs are in place, the number ranging from 20 to 35, but averaging about 28. The mucous matter binds all the eggs in a mass, and when the last is laid the mother devotes some time to filling up the somewhat narrower neck of the burrow with a compact and cellulose mass of the same material which, though light and easily penetrated, is more or less impervious to water, and forms a very excellent protection. (Fig. 21, *d.*)

[Fig. 19.]

ROCKY MOUNTAIN LOCUST:—Anal characters of female, showing horny valves.

[Fig. 20.]



OVIPOSITION OF ROCKY MOUNTAIN LOCUST.

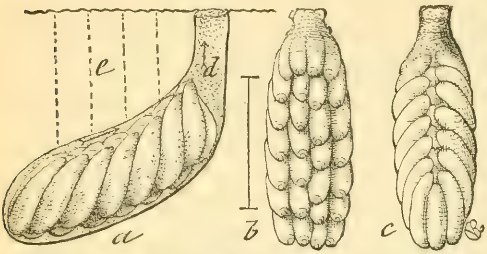
PHILOSOPHY OF THE EGG-MASS.

To the casual observer the eggs of our locust appear to be thrust indiscriminately in the hole made for their reception. A more careful study of the egg-mass or egg-pod will show, however, that the female took great pains to arrange them, not only so as to economize as much space as possible consistent with the form of

*This is a simple process or extension of the sternite, not particularized, that I am aware of, by any author. It may be known as the egg-guide or *gubernaculum ovi.*

each egg, but so as to best facilitate the escape of the young locust; for as the bottom eggs were the first laid and are generally the first to hatch, their issue would, in their efforts to escape, disturb and injure the other eggs, were there no provision against such a possibility. The eggs are, indeed, most carefully placed side by side in four rows, each row generally containing seven. They oblique a little, crosswise of the cylinder. (Fig. 21, *a*). The posterior or narrow end which issues first from the oviduct is thickened, and generally shows two pale rings around the darker tip (Fig. 22, *a*). This is pushed close against the bottom of the burrow which, being cylindrical, does not permit the outer or two side rows to be pushed quite so far down as the two inner rows; and for the very same reason the upper or head ends of the outer rows are necessarily bent to the same extent over the inner rows—the eggs when laid being somewhat soft and plastic. There is, consequently, an irregular channel along the top of the mass. (Fig. 21, *c*) which is filled only with the same frothy matter which surrounds each egg and occupies all the other space in the burrow not occupied by the eggs. The whole plan is seen at once by a reference to Figure 21, which represents enlarged, a side view of the mass within the burrow (*a*), and a bottom (*b*) and top (*c*) view of the same, with the earth which adheres to it, removed.

[Fig. 21.]

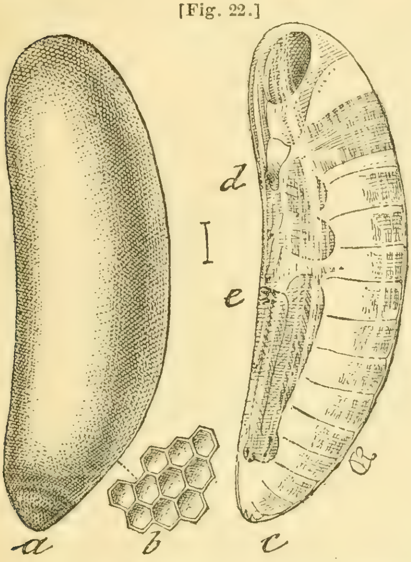


EGG-MASS OF ROCKY MOUNTAIN LOCUST:—*a*, from the side, within burrow; *b*, from beneath; *c*, from above—enlarged.

HOW THE YOUNG LOCUST ESCAPES FROM THE EGG.

Carefully examined, the egg-shell is found to consist of two layers. The outer layer which is thin, semi-opaque, and gives the pale cream-yellow color, is seen by aid of a high magnifying power to be densely, minutely and shallowly pitted; or, to use still more exact language, the whole surface is netted with minute and more or less irregular, hexagonal ridges (Fig. 22, *a*, *b*). The inner layer is thicker, of a deeper yellow, and perfectly smooth. It is also translucent, so that, as the hatching period approaches, the form and members of the embryon may be distinctly discerned through it. The outer covering is easily ruptured, and is rendered all the more fragile by freezing; but the inner covering is so tough that a very strong pressure between one's thumb and finger is required to burst it. How, then, will the embryon, which fills it so compactly that there is scarcely room for motion, succeed in escaping from such a prison? The rigid shell of the bird's egg is easily cracked by the beak of its tenant; the hatching caterpillar, curled within its egg-shell, has room enough to move its jaws and eat its way out; the egg-coverings of many insects are so delicate and frail that the mere swelling of the embryon affords means of escape; those of others so constructed that a door flies open, or a lid lifts by a spring, whenever pressure is brought to bear: in some, two halves open as in the shell of a muscle; whilst in a host of others the embryon is furnished with a special structure, called the egg-burster, the office of which is to cut or rupture the shell, and thus afford means of escape. But our young locust is deprived of all such contrivances, and must use another mode of exit from its tough and sub-elastic prison. Nature accomplishes the same end in many different ways. She is rich in contrivances. Every one who has been troubled by it must have noticed that the shanks (tibiæ) of our locust, as of all the members of its family, are armed with spines. On the four anterior legs, these spines are inside the shank; on the long posterior legs, outside. The spines of the hind shanks are strongest, and the terminal ones on all legs stronger than the rest. There can be no doubt that these spines serve to give a firm hold to the insect in walking or jumping; but they have first served a more important pre-natal purpose.

[Fig. 22.]



Egg of Rocky Mountain Locust:—*a*, showing sculpture of outer shell; *b*, the same very highly magnified; *c*, the inner shell just before hatching; *d*, *e*, points where it ruptures.

When fully formed, the embryon is seen to lie within its shell, as at Fig. 22, *c*. The antennæ curve over the face and between the jaws, which are early developed, and, with their sharp, black teeth, reach onto the breast. The legs are folded up on the breast, the strong terminal hooks on the hind shanks reaching toward the mesosternum. Now the hatching consists of a continued series of undulating contractions and expansions of the several joints of the body, and with this motion there is slight but constant friction of the tips of the jaws and of the sharp tips of the hind tibial spines, as also of the tarsal claws of all the legs against the shell, which eventually weakens between the points *d* and *e*, and finally gives way there. It then easily splits up to the eyes or beyond, by the swelling of the head.

By the same undulating movements the nascent larva soon works itself entirely out of the egg, when it easily makes its way along the channel already described, without in the least interfering with the other eggs, and finally forces a passage-way up through the mucous filling in the neck of the burrow (Fig. 21, *d*). Once fully escaped from the soil, it rests from its exertions, but for a short time only. Its task is by no means complete: before it can feed or move with alacrity it must molt a pellicle* which completely encases every part of the body. This it does in the course of three or four minutes, or even less, by a continuance of the same contracting and expanding movements which freed it from the earth, and which now burst the skin on the back of the head. The body is then gradually worked from its delicate covering until the last of the hind legs is free and the exuvium remains, generally near the point where the animal issued from the ground, as a little, white, crumpled pellet. Pale and colorless at first, the full-born insect assumes its dark-gray coloring in the course of half an hour.

From this account of the hatching process, we can readily understand why the female in ovipositing prefers compact or hard soil to that which is loose. The harder and less yielding the walls of the burrow, the easier will the young locust crowd its way out.

The covering which envelops the little animal when first it issues from the egg, though quite delicate, undoubtedly affords protection in the struggles of birth from the burrow, and it is an interesting fact that while it is shed within a few minutes of the time when the animal reaches the free air, it is seldom shed if, from one cause or other, there is failure to escape from the soil, though the young locust may be struggling for days to effect an escape.

While yet enveloped in this pellicle, the animal possesses great forcing and pushing power, and if the soil be not too compact, will frequently force a direct passage through the same to the surface, as indicated at the dotted lines, Fig. 21, *e*. But it can make little or no headway, except through the appropriate channel (*d*), where the soil is at all compressed. While crowding its way out, the antennæ and four front legs are held in much the same position as within the egg, the hind legs being generally stretched. But the members bend in every conceivable way, and where several are endeavoring to work through any particular passage, the amount of squeezing and crowding they will endure is something remarkable. Yet if by chance the

* This pellicle (the *amnion*) is common to most Orthopterous and Neuropterous insects.

protecting pellicle is worked off before issuing from the ground, the animal loses all power of further forcing its way out. The instinctive tendency to push upwards is also remarkable. In glass tubes, in which I have had the eggs hatching in order to watch the young, these last would always turn their heads and push toward the bottom whenever the tubes were turned mouth downward; while in tin boxes where the eggs were placed at different depths in the ground, the young never descended, even when they were unable to ascend on account of the compactness of the soil above.

ADDITIONAL NATURAL ENEMIES.

The enemies of the Rocky Mountain Locust may be divided into those which destroy the eggs and those which attack and destroy the active insects.

Animals which destroy the eggs.—In addition to the Black-bird and Prairie Chicken, previously mentioned as feeding on the eggs, Mr. Geo. F. Gamner, of Lawrence, Kans., has found the Lapland Longspur (*Plectrophanes lapponicus*), the Horned Lark (*Eromophila cornuta*) and the Quail doing the same good work, feeding especially on such eggs as are exposed by freezing and thawing. Mr. J. W. Robson, of Cheever, Kans., has found the Skunk and Striped Squirrel destroying large numbers of the eggs, and the *Greeley* (Col.) *Sun* reports five acres of land dug all over by the former animal in search of them. The Silky Mite (*Trombidium sericium*), the habits of which were related in my 7th Report, did much good in destroying the eggs in the more northern States. In parts of Minnesota it reduced them to a powder over extensive areas, and as the power of these minute scarlet bodies for good as egg-destroyers has been questioned, I give the following reports, which tell their own story:

Last evening, when we reached Worthington from Lake Shetek, there was quite an excitement in Worthington, owing to the fact that the citizens were generally convinced that a red parasite was destroying the grasshopper eggs. I examined the matter carefully myself, and became convinced that the destruction of the eggs in that immediate vicinity was well assured; but I determined not to write you and excite any hope until a further and more complete examination could be had. We therefore furnished our Bohemian friends with a bottle of the eggs and *their pests*, and the commission left in high spirits. We postponed further investigation until this morning, when I left and prosecuted the examination with vigor. The farmers in the vicinity knew nothing of these signs of deliverance until the visitors from Worthington reached them, and I feel safe in saying to you that in a circle of ten miles from Worthington there will scarcely be an egg left by to-morrow night. I send you a bottle herewith containing the cones and the parasites. We could scarcely find a cone or sack, except as they were indicated by the parasite on the surface; and each cone, which was not entirely destroyed, had from five to fifty of the red laborers at work upon the eggs. We found scores of cells with no eggs left, except the shells.

* * * * * * * * * * *

I stopped for fifteen minutes one-and-a-half miles west of Wilder, where Section Foreman Smith took me to that portion of his farm where eggs were deposited. We could find none by general digging, but wherever we found, as we frequently did, the red parasite on the surface, we found the cone beneath, with the parasite at work consuming the eggs. * * * I am aware that two years ago this parasite was found working upon the eggs at Madelia and other places, but here we have the remedy almost as soon as the eggs are laid, while in the former instances the parasite was only discovered in the Spring.—[Letter from Ex-Gov. Stephen Miller, written from Windom, Minn., Aug. 15, 1876.

We send herewith a box of grasshopper eggs, together with the "silky mite," of which so much has been said. You can see a sample of the work they are doing. They are over the ground and in it wherever eggs have been laid. They suck the eggs, leaving the bare shell. We have talked with farmers from all parts of the county, and they all tell the same story—not a cell to be found that is not partially or wholly destroyed.

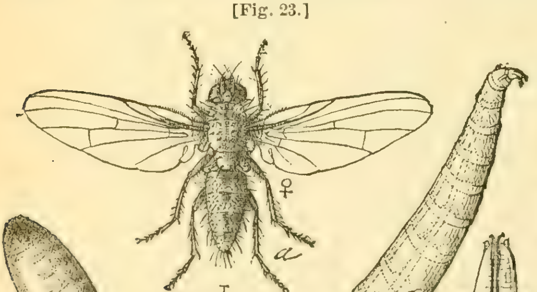
We have personally inspected them in more than twenty different places, and are satisfied that in this county the eggs of the festive G. H. are a "total wreck." Allow us to suggest that you call for a report from every county in the State that has been infested by them.—[Letter to *Pioneer Press and Tribune*, from Bell & Gruelle, Worthington, Nobles Co., Minn., Aug. 16, 1876.

I send, enclosed in a circular tin box, mailed with this, some dirt containing grasshopper's eggs, and also the *red mite* or *spider* that sucks them, as you will perceive on examination. I trust they will be received in good order. I send them at the request of A. Whitman, of St. Paul, of this State, with whom I am corresponding sometimes on this grasshopper matter.—[Letter from R. B. Potts, U. S. N., Worthington, Minn., August 18, 1876.

Up to the past autumn the Silky Mite was the only parasite that was known to attack the eggs of our locust, though a small Chalcid-fly* had been bred by Mr. S. H. Scudder, from those of the Carolina Locust, a large species with blue and black hind wings; and two Ichneumon-flies were known to attack locust eggs in Europe. The present year five new insect enemies have been found attacking these eggs almost everywhere throughout the infested country, and these I will proceed to describe.

THE ANTHOMYIA EGG PARASITE, (*Anthomyia radicum*, var. *caloptenі.*)—This is by far the most wide-spread and generally useful of the different egg enemies. It has occurred in Minnesota, Iowa, Nebraska, Kansas, Missouri and Texas, and wherever I have examined the locust eggs, whether in Missouri, Kansas or Nebraska, I have found it destroying on an average about ten per cent. of them. It is the enemy referred to by Mr. Jno. D. Dopf, of Atchison, and by Mr. J. D. White, of Holt county, in the reports from Missouri,

[Fig. 23.]



ANTHOMYIA EGG-PARASITE:—*a*, fly; *b*, pupa; *c*, larva from side; *d*, head of same from above—enlarged.

*A similar, if not the same Chalcid, infests the eggs of *spretus*, for Mr Potts has sent me egg-masses in which every egg had a Chalcid pupa. Unfortunately, they were too dry when received to permit of rearing the imago.

(ante, pp. 68, 72.) and the following items will serve as samples of many others that referred to the same parasite:

Recently a white worm or maggot has been discovered in the locust eggs laid in this vicinity, and so generally are the grubs that we really look for a great diminution in next year's locust crop. About the time the hoppers began laying eggs we had a hard, soaking rain, and since then we have had several more—the last this morning. By this time the ground is well soaked with water and the eggs were and are laid in earth that is quite moist. It is about two weeks since the hoppers first reached Mankato, they have laid many eggs, and already this worm or maggot has developed and seems to be on the increase, being found in the egg cells, where it sucks or destroys the egg. Some cells that I have opened have had two and three worms in them.—[From a letter from J. C. Wise, Mankato, Minn., August 20, 1877.

On the ninth I sent you a box of locust egg parasites, and to-day I will send you some more of different sorts or different stages of development or both. I find them more plentiful to-day than before. The ground seems to be full of them from 5 to 20 of the small white worms in a single cell, one generally, though sometimes two of the large white ones in a cell. The reddish covered ones I suppose are in a different stage of development, though the same parasite. In every cell in which I have found any of those sent you the eggs were nearly or quite destroyed. But there is another, and a far more destructive enemy, viz: the hot sun, which is hatching them out by the million, though the parasites may continue their work after it ceases to operate. I shall be happy to do all I can to aid you in your investigations—[Letter from C. E. Treadwell, Rockport, Atchison county, October 16, 1876.

Yesterday we discovered on a warm southern exposure that our locust eggs were hatching out maggots. We break open the cocoons and the eggs on exposure to the sun for a few moments crawl away a worm. In warm places along the hedges the earth is alive with them. Is this a new development of the locust question? It would seem to be a confirmation of the theory you promulgated, as I understood it, at the time. I secured a few of the perfect cocoons which I enclose for your examination. We suppose these will do as the others do upon exposure to the sun.

The people here are quite excited over the matter, hoping it may be a solution of the problem for next year, at least, and have deputed me to lay the matter before you. Any information you can give us in regard to this our latest development, will be thankfully received and acknowledged—[Letter from S. M. Pratt, M. D., Hiawatha, Brown county, Kansas, October 30, 1876.

Various reports have been circulated in regard to the destruction of the eggs of the Rocky Mountain Locust (Caloptenus spretus) by a worm. I am happy to state that these reports were substantiated yesterday by Mr. McLockhead of Deer Creek, Kanawaka, twelve miles west of this city, who brought me a box of earth in which the eggs of the "hopper" had been abundantly deposited. To-day a similar box was secured from W. B. Barnett, Esq., of Hiawatha, Brown county. In both of these instances a large proportion of the eggs have been destroyed by a small, white larvæ. Many of the egg-cases, which ordinarily each contain from twenty to thirty eggs, had no eggs in them, but were full of these worms or larvæ, each one of which took the place of an egg which it had destroyed. Some of the egg-cases contained only two or three larvæ with more than twenty sound eggs. I consider these to be the larvæ of a parasitic Hymenopterous insect [it was subsequently verified as the Anthomyia under consideration] which I hope to obtain in the winged or perfect state, if I succeed in carrying them safely through their transformation—[Prof. F. H. Snow, in *Lawrence* (Kansas) *Journal*, November 1, 1876.

This good little friend, which simultaneously prevailed over so large an extent of country, is a small white maggot, (Fig. 23, *c*) of the same general form of the common meat maggots or "gentiles," but measuring, when full grown and extended, not quite $\frac{1}{4}$ of an inch in length. The head, with some of the anterior joints of the body, tapers and is retractile, and the jaws consist of two small hooks joined to a V-shaped, black, horny piece which, as it is retracted or extended, plays beneath the transparent skin. The hind or tail end is squarely docked off, and contains two small yellowish-brown, eye-like spots, which are the principle spiracles or breathing pores.

These small maggots are found in the locust egg-pods, either singly or in varying numbers, there sometimes being a dozen packed together in the same pod. They exhaust the juices of the eggs and leave nothing but the dry and discolored shells, and where they are not numerous enough to destroy all the eggs in the pod, their work, in breaking open a few, often causes all the others to rot.

When fed to repletion this maggot contracts to a little cylindrical, yellowish-brown pupa, (Fig. 23, *b*) about half the length of the outstretched and full-grown larva, and rounded at both ends. From this pupa, in the course of a week in warm weather, and longer as the weather is colder, there issues a small, grayish, two-winged fly, (Fig. 23, *a*) about $\frac{1}{4}$ of an inch long, the wings expanding about $\frac{1}{2}$ of an inch, and in general appearance resembling a diminutive house-fly, except that the body is more slender and more tapering behind, and the wings relatively more ample. More carefully examined, the body is seen to be of an ash-gray color, tinged with rust-yellow, and beset with stiff bristle-like hairs, those on the thorax stoutest, and those on the abdomen smaller but more uniformly distributed. The wings are faintly smoky and iridescent. There are three dusky longitudinal stripes on the thorax, most distinct anteriorly, and another along the middle of the abdomen, most distinct in the male, which also differs from the female in the larger eyes, which meet much more closely on the top of the head than in the female, and in the face being whiter.

The Winter is passed mostly in the pupa state, though doubtless in some cases also in the winged state.

The flies of this genus are characterized by the shortness of the antennæ, and by the attenuated abdomen. The characters given to it are, however, by no means uniform, and as the species generally bear a very close resemblance to each other, and there have been a large number described in Europe, (many of them very imperfectly), it becomes almost an impossibility to properly determine them. As the sexes often differ materially, it is also, except where they are reared from the larva, difficult to connect them, and as the colors often become sordid and dull in the cabinet, many of the described species have no real existence.

The flies frequent flowers, and often congregate and play in swarms in the air. Their eggs are white, smooth, oval, about 0.04 inch long, and are dropped near the food of the larva. In the larva state these insects mostly feed on leguminous plants, and the carnivorous habit is exceptional. The species affecting the Cabbage, the Onion, the

Radish etc., have received different names as *brassicæ*, *ceparum*, *raphani*, etc., but several of them doubtless constitute but one species. A comparison of those reared from the locust eggs with the descriptions of *brassicæ* and *ceparum* has not enabled me to discover any constant differences, and they should perhaps all be referred to *radicum* Linn. At all events I feel that it is safest to define the insect under consideration merely as a variety of that species, leaving the proper determination of it to the future monographer of the genus.

The probabilities are that, feeding normally on the roots of various plants, it found locust eggs to its liking, and multiplied rapidly as a result of the abundance of such eggs.

ANTHOMYIA RADICUM (Linn.) var. CALOPTENI—*Egg*—Oval, smooth, white, 0.04 inch long.

Larva—Skin unarmed, 0.24 inch long when extended, of the normal form, the mandibular hooks black, quite conspicuous, and diverging at base. Prothoracic spiracles elongate. Anal spiracles minute, yellowish-brown, with the 8 fleshy surrounding tubercles, small.

Pupa—Pale-brown, rounded at each end, with the prothoracic spiracles and lips anteriorly, and the anal spiracles and lower tubercles posteriorly, showing as minute points.

Imago—♀. Average expanse 0.48 inch. General color ash-gray with a ferruginous hue, especially above, and a more or less intense metallic reflection. Face with white reflections below; eyes smooth, brown, encircled by the ground color, and this behind and on forehead bordered by a brown line; 2 similar lines at back of head from upper corners of eyes and approaching to neck; forehead dusky-brown, becoming bright yellowish-red toward base of antennæ, and the brown forking at right angles around occiput. Trophi and antennæ black, the style simple and somewhat longer than the whole antennæ. Thorax with three dusky longitudinal lines, obsolete behind; legs black, with cinereous hue beneath; wings faintly smoky, with brown-black veins, the discal cross-vein straight and transverse, the outer one bent and more oblique; balancers crumpled, yellowish. Abdomen with faint dusky medio-dorsal spots, broad at base, tapering and obsolescing toward end of each joint.

In the ♂, aside from the larger eyes, stronger bristles, and narrower, less tapering abdomen with its additional joint—all characteristic of the sex—the face is whiter, and the medio-dorsal dark mark of abdomen continuous.

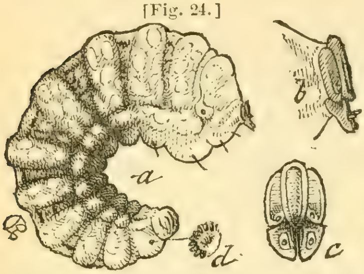
Described from 25 specimens of both sexes, reared from locust-egg-feeding larvæ.

Specimens bred from cabbage and raddish roots, and others in my cabinet taken from the burrows (made in Osage Orange in Missouri) of *Crabro stirpicola* Pack.; do not differ specifically.

THE COMMON FLESH FLY (*Sarcophaga carnaria*, L.)—The red-tailed variety (*sarraceniæ*) of this ubiquitous insect, described and figured in my 7th Report (p. 180) as preying on the locust, also attacks its eggs. It is a larger maggot than the preceding, and contracts to a darker pupa which is not similarly rounded at each end, but has the hind end truncate, and the front end tapering. It sucks the eggs, as does the Anthomyia larva, but the parent fly is probably attracted to those, principally, which are addled or injured, as the pods in which I have found it have very generally been in a fluid state of decay. From three quarts of eggs I have obtained 26 of these flies.

UNDETERMINED SPECIES.—Next to the Anthomyia Egg-parasite, in importance, is a much larger, more sluggish, yellowish grub, (Fig. 24) measuring about $\frac{1}{2}$ an inch when extended, which is found within or beneath the locust eggs, lying in a curved position, the body being bent so that the head and tail nearly touch each other. It is a smooth grub, with a very small, brown, flattened head, with the joints near the head swollen and the hind end tapering, and with deep, translucent sutures beneath the joints, which sutures show certain vinous marks and mottlings, especially along the middle of the back. It exhausts the eggs, and leaves nothing but the shrunken and discolored shells. It has not yet been reared to the perfect state, but from the structure of its mouth it is evidently Hymenopterous, and will produce, without much doubt, some Ichneumon-fly. It has been found in Minnesota, Iowa, Kansas and Missouri, and has destroyed about one per cent. of the eggs.

[Fig. 24.]



UNDETERMINED EGG-PARASITE OF R. M. LOCUST.

The following letters refer to this species:

The other day as I was strolling through the fields, I stopped to examine some eggs. I found the ground in spots quite full of white grubs, worms or maggots, whatever they may be called. Many of them were in the egg-pods, busy at work. I collected a few, and sent to you in a small vial by mail for your examination. The ground was high and dry where found.—[From S. D. Payne, Kasota, Le Sueur county, Minn., Sept. 28, 1876.

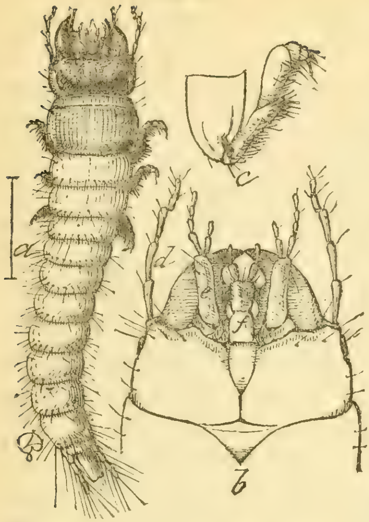
I think the silky mite has done good service in destroying eggs in one or two counties, particularly Noble. But we are getting, in addition, continual newspaper reports of white grubs destroying the eggs. I started out to see for myself, and have found a number which I send you.—[From A. Whitman, St. Paul, Minn., September 7, 1876.

This grub is found of various sizes as Winter sets in, and hibernates without change. It will doubtless be reared to the perfect state the coming Summer, and I give a more detailed description herewith.

Average length 0.50 inch. Body curved, glabrous, tapering posteriorly, swollen anteriorly. Color opaque whitish, with translucent yellowish mottlings and some vinous marks at sutures, especially along medio-dorsum. Sutures deep. A lateral row of swellings. Head small, flattened, dark-brown, in five pieces, consisting above of a frontal ovoid piece and two lateral pieces of somewhat similar form, and each bearing near tip a minute, 2-jointed palpus; beneath of two broad, sub-triangular jaws having forward and lateral motion, and each also bearing near the center, in a depression, a 2-jointed feeler. A spiracle each side in a fold between joints 2 and 3, and another on each side of the penultimate joint, 12. None otherwise perceptible.

Besides the three preceding species which have been found destroying the eggs the past year, and which, from their being generally

[Fig. 25.]



HARPALUS ? LARVA THAT PREYS ON LOCUST EGGS:—*a*, larva, from above; *b*, head, from beneath; *c*, leg—enlarged.

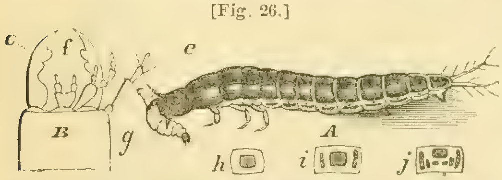
found within the egg-pod, may be called parasitic, though they are not strictly so; I have also found the larvæ of two species of Ground-beetles (*Carabidæ*) attacking said eggs. One pale species, (Fig. 25) evidently belonging to the genus *Harpalus*, is more particularly common and busy in the good work. It is an active creature, something over half an inch long, with powerful jaws and a light brown head and prothorax, and the rest of the body pale, tapering posteriorly and ending in a stout proleg and two articulate appendages. For the entomological reader I append a more detailed description:

Color yellowish white; prothorax and head highly polished yellowish-brown, the jaws darker. Head broad, depressed and rugose in front; jaws broad, robust, dark, and with but one strong middle tooth; antennæ 5-jointed, joints 4 and 5 scarcely equaling 3 in length; maxillæ elongate, subcylindrical, with a 4-jointed outer and a 2-jointed inner palpus; mentum elongate, its base soldered with the lower head; labrum also elongate and with 2-jointed palpi; all trophi armed with stiff hair. Prothoracic joint, swollen, wider than head, twice as long as succeeding joint, horny, and with a darker anterior border, limited by a transverse stria posteriorly and marked with fine longitudinal striæ. Legs, except coxæ, dark brown and thickly beset with short, spinous bristles of the same color. Abdomen tapering to end, with no horny plates, but each joint with two transverse rows of stiff yellowish hairs, the posterior rows strongest. Anal proleg stout, the cerci 4-jointed (joints 3 and 4 small and imperfectly separated) and reaching but little beyond it; eyes small, dark and just behind base of antennæ. Length of largest specimens 0 58 inch.

Eight specimens feeding on eggs of *Caloptenus spretus*.

The other Ground-beetle, belonging probably to the same genus as the above, is of about the same size and has precisely the same structure. It is at once distinguished, however, by a series of broad, dark-brown, horny plates along the back, by paler horny pieces along the sides and beneath; by the darker, somewhat narrower prothorax; by the pale legs, and by the shorter anal cerci. I have found three specimens of this last feeding on the eggs, and one was sent to me as having the same habit, by Mr. Whitman, of St. Paul. Mr. G. F. Gaumer has sent me what he took to be a minute Rove-beetle

[Fig. 26.]



HARPALUS ? LARVA:—*B*, under-side of head; *h*, *i*, *j*, under-side of different joints of body.

(*Staphilinidæ*) found feeding on the eggs, and they prove to be newly-hatched specimens of the above *Harpalus* larva.

It is probable that most of the Carabid larvæ will feed on the eggs, and I introduce the figure of a larger species (Fig. 26) and its probable parent, the Pennsylvania Ground-beetle (*Harpalus pennsylvanicus* De Geer, Fig. 27).

Insects which destroy the active Locust.—In addition to the many animals enumerated in previous reports, which destroy this locust, the Box-turtle may be mentioned, and Mr. Gaumer has found a large burrowing spider (doubtless a *Lycosa* or *Mygale*) to feed upon it. He has also examined several specimens infested with hair-worms, one of which was 18½ inches long. I have myself taken a specimen 6½ inches long, which proves, upon comparison, to be our commonest species, *Gordius aquaticus.* Mr. H. A. Brous, who, while in Western Kansas last Summer, made careful notes of everything he observed relating to the Rocky Mountain Locust, has sent me a number of insects found preying upon it that had not before been observed at such work. Among them are various Asilus-flies*, and several Ground-beetles and Tiger-beetles.† More particulary noteworthy among these last is that large and most elegant dark-brown species which I herewith figure (Fig. 29), and which has been esteemed as a great rarity among Coleopterists. Mr. Brous found it much more common than it was generally supposed, and attributes its reputed rarity to its secretive and nocturnal habits. It lives in holes in clayey banks, and issues in search of food only at night or early morn. Of Heteroptera, there is a Soldier-bug of the genus *Apiomerus* and allied to *crassipes*; and of Hymenoptera there are two Ichneumons—a *Compoplex* and *Ephialtes notanda* Cress—that were noticed pursuing the locusts, and are possibly parasitic upon them. The Preying Mantis (*Mantis Carolina*, Rep. 1, p. 169) has been also ob-

[Fig. 27.]

PENNSYLVANIA GROUND-BEETLE.

[Fig. 29.]

AMBLYCHILA CYLINDRIFORMIS.

[Fig. 28.]

ERAX BASTARDII.

* *Stenopogon consanguineus* Loew., a species with pale yellowish hairs on head and thorax, yellowish-brown wings and pale rufous legs and abdomen; *Promachus apivora* Fitch; *Erax Bastardii;* several allied species of *Erax*, and a species of *Tolmerus*.

† *Pasimachus elongatus* Lec.; *P. punctulatus* Hald.; *Calosoma obsoletum* Say; *Cicindela pulchra* Say; *C. scutellaris* Say; *C. 6-guttata* Fabr.; *C. fulgida* Say; *C. vulgaris* Say; *C. circumpicta* Laf.; *C. formosa* Say; *C. punctulata* Fabr.

served feeding on the locusts by Mr. H. S. King in Texas and by Mr. Brous in Kansas.

EXPERIMENTS WITH THE EGGS, AND CONCLUSIONS DRAWN THEREFROM.

There are many questions respecting the manner in which the eggs of this locust are affected under different conditions, which are of intense practical interest, and which are frequently discussed with no definite result being arrived at, or no positive conclusion drawn. Such are, for instance, the influence of temperature, moisture and dryness upon them; the effects of exposing them to the air, of breaking open the pods, of harrowing or plowing them under at different depths, of tramping upon them. Everything, in short, that may tend to destroy them or prevent the young locusts hatching, is of vital importance. With a view of settling some of these questions, and in the hope of reaching conclusions that might prove valuable, I have carried on, during the past Winter, a series of experiments, some of which are herewith summed up. By reference to the meteorological table given further on, in considering the "Condition of the Eggs," the exact temperature at any of the dates mentioned can be ascertained.

Experiments to test the Effects of alternately Freezing and Thawing.

The eggs in the following series of experiments were obtained early in November, at Manhattan, Kans., under similar conditions. They were mostly in a fluid state at the time, and none but good and perfect masses were used. They were all carefully placed in the normal position at the surface of the ground, in boxes that could be easily removed from place to place. The experiments commenced November 10th, 1876, and ended March 10th, 1877. During November and December the weather was severe, while during January and February it was largely mild and genial for the season. In March again there was much frost.

The temperature in my office, into which all the eggs when not exposed were brought, ranged during the day from 65° to 70° F., rarely reaching to 75°. During the night it never dropped below 40°, and averaged about 55°.

Experiment 1.—Fifty egg-masses were exposed to frost from November 10th to January 10th, and then taken in-doors. In 20 days they commenced hatching, and continued to do so for 38 days thereafter.

Experiment 2.—Fifty egg-masses exposed at the same time to frost. Brought in-doors on December 10th. On December 31st they commenced hatching numerously and continued to hatch till the 10th of January, 1877, when the remainder were exposed again. The weather being subsequently mild, some hatched on each warm day until the 26th. None hatched thereafter, and upon examination, subsequently, all were found to have hatched.

Experiment 3.—Fifty egg-masses exposed at same time. Brought in-doors December 1st. Kept there till the 22d without any of them hatching. Exposed again for three weeks, and then brought in-doors on the 12th of January. They commenced hatching two days thereafter, and continued till the 29th. Subsequent examination showed them all to have hatched.

Experiment 4.—One hundred egg-pods exposed at the same time, but alternately brought in-doors and exposed again every 14 days. Some commenced hatching during the second term in-doors; others continued during the warm days of the third exposure, and all had hatched by the sixth day of the third term in-doors.

Experiment 5.—A lot of 100 egg-masses alternately exposed and brought in-doors every week. During the first four terms of exposure they were continuously frozen, while during the next four the weather was frequently mild enough to permit hatching. They first began to hatch during the fourth term in-doors, and continued to hatch, except during the colder days when exposed, until the seventh term in-doors, during which the last ones escaped.

Experiment 6.—Many hundred egg-masses kept out-doors the whole time, first commenced hatching March 2d.

Experiment 7.—Many hundred pods, kept in-doors till December 15, and hatching from November 28th up to that time, were then exposed, and have continned to hatch whenever the weather permitted, and continue to hatch up to the present time (March 10.)

Experiment 8.—A lot of 100 pods that had been hatching in-doors from November 19th, were exposed to frost January 15th, and brought in-doors again January 28th, where they continued hatching till February 10th. Every one was subsequently found to have hatched.

Experiment 9.—A lot of 100 under same conditions as in experiment 8, up to January 28th. They were then exposed again and brought in-doors February 16th, when they commenced hatching and continued to do so till the 27th. All were found subsequently to have hatched.

Two important conclusions are deducible from the above experiment:

First—The eggs are far less susceptible to alternate freezing and thawing than most of us, from analogy, have been inclined to believe. Those who have paid attention to the subject, know full well that the large proportion of insects that hibernate on or in the ground, are more injuriously affected by a mild, alternately freezing and thawing Winter, than by a steadily cold and severe one; and the idea has quite generally prevailed, that it was the same with regard to our locust eggs. But, if so, then it is more owing to the mechanical action which, by alternate expansion and contraction of the soil, heaves the pods and exposes them, than to the effects of the varying temperatures.

Second—That suspended development by frost may continue with impunity for varying periods, after the embryon is fully formed and the young insect is on the verge of hatching. Many persons, having in mind the well known fact that birds' eggs become addled if incubation ceases before completion, when once commenced, would, from analogy, come to the same conclusion with regard to the locust eggs. But analogy here is an unsafe guide. The eggs of insects hibernate in all stages of embryonic development, and many of them with the larva fully formed and complete within. The advanced development of the locust embryo, frequently noticed in the Fall, argues nothing but very early hatching as soon as Spring opens. Their vitality is unimpaired by frost.

Experiments to test the Influence of Moisture upon the Eggs.

The following series of experiments were made with eggs also brought from Manhattan, Kansas. They were dug up in December, and were sound, and much in the same condition as those in the preceding series.

The water in all but the last three, or experiments 23, 24 and 25, was kept in my office at the temperature already stated, and only changed when there was the least tendency to become foul. In the alternate submergence and draining, the eggs were submitted to the most severe hygrometric changes; the warm atmosphere of the room having great drying power.

Experiment 10.—Ten egg-masses kept under water in-doors from December 5th to December 26th, 1876, the water becoming quite foul. They were then removed to earth and kept in a hatching temperature. They commenced hatching January 11th, 1877, and continued to do so till February 5th—all having hatched.

Experiment 11.—Twenty egg-masses kept under water in-doors from December 26th, 1876, till January 2d, 1877; then left dry till the 9th; then submerged again till the 16th, when they were drained again. On the 20th, 18 young hatched, and others continued hatching till the 23d, when they were submerged again. From the 26th to 30th, a few hatched under water, successfully getting rid of the post-natal pellicle, and living for some hours afterward in the water. On the 30th day they were drained again, and continued to hatch. On February 6th, they were again immersed, and continued to hatch on the 7th. On the 15th, 22d, 29th, and March 7th, they were alternately drained and immersed; but none hatched after February 7th, and the remainder proved upon examination to have been destroyed, most of them being quite rotten.

Experiment 12.—Two egg-masses taken from the lot in Experiment 11, on February 7th, and placed in moist earth. Every egg subsequently hatched.

Experiment 13.—Two egg-masses taken from the lot in Experiment 11, on February 22d, and placed in moist earth. All hatched.

Experiment 14.—Twenty egg-masses alternately immersed and drained every two weeks from December 26th till March 6th. None hatched, but three-fourths of the eggs were at this date sound, the embryon full-formed and active as soon as released, but pale, and evidently too feeble to burst the egg-shell. The rest were killed and more or less decomposed.

Experiment 15.—Two egg-masses, after immersion for two weeks, were placed in moist earth. They began hatching 22 days afterward, and continued to do so for 6 days. It was subsequently found that only seven out of forty-eight eggs had collapsed and failed to hatch.

Experiment 16.—Two egg-masses immersed for two weeks, and drained for two weeks; then placed in moist earth. Six days afterward they commenced hatching, and continued to do so for 2 days. Subsequently examined, 28 out of 54 eggs had perished.

Experiment 17.—Two egg-masses alternately immersed, drained, and immersed again every two weeks, were placed in moist earth. They commenced hatching two days afterward, and continued to do so for 12 days. Upon subsequent examination, 23 out of 52 had perished.

Experiment 18.—Twenty egg-masses immersed from Dec. 26, 1876, to Jan. 16, 1877; then drained till Feb. 6th, then immersed till Feb. 27th, then drained again. On Feb. 3d, while dry, they commenced hatching numerously, and a few continued for two days to hatch while immersed. An examination March 7th, showed about half of them still alive, the rest rotten.

Experiment 19.—Twenty egg-masses immersed from Dec. 26, 1876, to Jan. 23, 1877; then drained till Feb. 20th, then submerged again. They commenced hatching on the 6th of Feb., and continued two days after the second submergence. On the 7th of March but about 5 per cent. had rotted.

Experiment 20.—Two egg-masses immersed for 4 weeks; then drained for 2 weeks; then immersed for one week; then placed in moist earth. They commenced hatching 7 days afterward, and continued to do so for 6 days. Subsequently examined, one of the masses was rotten; the eggs in the other had all hatched.

Experiment 21.—Twenty egg-masses kept from Dec. 26th, 1876, in earth saturated with moisture. On Feb. 23d, 1877, they commenced hatching, and continued to do so till March 7th, when all were found to have hatched, except one pod, which was rotten.

Experiment 22.—Twenty egg-masses, alternately placed every five days, from Dec. 26, 1876, in earth saturated with moisture and in earth which was very dry. Commenced hatching Feb. 14th, and continued till March 7th, when, upon examination, 9 of the pods were found rotten.

Experiment 23.—Twenty egg-masses immersed and exposed out-doors Dec. 26, 1876. From that time till March 7th, the water was frozen and completely thawed at 6 different times, the vessel containing them, which was of glass and admitted the sunlight, several times breaking. The changes were as follows: Frozen till Jan. 10th; then thawed till the 12th; then frozen till the 18th; then thawed till the 20th; then frozen till the 26th; then thawed till Feb. 20th; then partly frozen till the 22d; then thawed till the 26th; then frozen till the 27th; then thawed till March 5th; then frozen. Examined on the 7th of March, one pod only was found rotten; the others apparently sound.

Experiment 24.—Two egg-masses under same conditions as in Expt. 23, till Feb. 9th, when they were brought in-doors and placed in earth. One was dried up on the 16th; the other commenced hatching on the 27th, and when examined on March 7th, all the eggs in it were found to have hatched.

Experiment 25.—Two egg-masses under same conditions as in Expt. 23, till Feb. 27th, when they were placed in earth in-doors. Those examined March 7th were sound, and near the hatching point.

These experiments, though not yet completed at the time this MS. goes to the printer, yet establish a few facts that were somewhat unexpected. The insect is a denizen of the high and arid regions of the Northwest, and has often been observed to prefer dry and sunny places, and to avoid wet land, for purposes of ovipositing. The belief that moisture was prejudicial to the eggs, has, for these reasons, very generally prevailed. The power which they exhibit of retaining vitality, and of hatching under water or in saturated ground, is, therefore, very remarkable—the more so when viewed in connection with the results obtained in the succeeding experiment. That the eggs should hatch after several weeks submergence, and that the young insect should even throw off the post-natal pellicle,was, to me, quite a surprise, and argues a most wonderful toughness and tenacity. After being dried and soaked for over six weeks, under conditions that approach to those of Spring, I found a good proportion of the eggs to contain the full-formed and living young, which, though somewhat shrunken, and evidently too weak to have made its exit, was still capable of motion. The water evidently retards hatching. An examination of the submerged eggs that remained unhatched long after others had hatched, which had been under similar treatment up to a certain time, and then transferred to earth, showed the jaws and tibial spines to be still quite soft. It is, therefore, in preventing the proper hardening of these delivering points, that water doubtless retards the hatching, and prevents its accomplishment long before the embryon perishes. Yet, when once life has gone, the egg would seem to rot quicker in the water than in the ground.

The results of Experiments 23—25 prove conclusively that water in Winter time, when subject to be frozen, is still less injurious to the eggs.

Altogether, these experiments give us very little encouragement as to the use of water as a destructive agent; and we can readily understand how eggs may hatch out, as they have been known to do, in marshy soil, or soil too wet for the plow; or even from the bottom of ponds that were overflowed during the Winter and Spring. While a certain proportion of the eggs may be destroyed by alternately soaking and drying the soil at short-repeated intervals, it is next to impossible to do this in practice during the Winter season as effectually as it was done in the experiments; and the only case in which water can be profitably used is where the land can be flooded for a few days just at the period when the bulk of the eggs are hatching.

Experiments to test the Effects of Exposure to the Free Air.

The eggs in the following series were obtained at Manhattan, Kansas, in November, and all under similar conditions.

Experiment 26.—A large number of egg-masses were thoroughly broken up and the single eggs scattered over the surface of the ground out-doors early in December. By the 23d of February all had perished, and most of them had collapsed and shriveled.

Experiment 27.—A large number of pods were partly broken up and exposed as in Exp. 26. On the 10th of March the outer eggs were mostly dead and shrunken, but a few of the protected ones were yet plump, the embryon well advanced and apparently sound.

Experiment 28.—A large number of unbroken pods were exposed under similar conditions as in the preceding Expts. By March 10th fully three-fourths of the eggs had perished.

Experiment 29.—Fifty egg-masses were kept in-doors in an open mouthed bottle in perfectly loose and dry earth from November 6th. Fully 8 per cent. of the eggs had hatched by December 28th, when hatching ceased, and a subsequent examination showed the rest to have shrunken and perished.

It is very evident from the above experiments that we can do much more to destroy the eggs by bringing into requisition the universally utilizable air, than we can by the use of water. The breaking up of the mass and exposure of the individual eggs to the desicating effects of the atmosphere, effectually destroys them; and when to this is added the well known fact that thus exposed they are more liable to destruction by their numerous enemies, we see at once the importance of this mode of coping with the evil.

Experiments to test the Effects of burying at different Depths, and of pressing the Soil.

The following series of experiments were made with eggs obtained at Manhattan, Kansas, early in November, and which were in similar condition to those in the first series. Large tin cylindrical boxes, made of different depths, and varying from 4 to 8 inches in diameter were used; and in order to hasten the result they were kept in-doors at the temperature already mentioned. The soil in all the boxes was finely comminuted and kept in uniform and moderately moist condition. It was gently pressed with the fingers, so as to approach in compactness the surface soil of a well cultivated garden. In each instance the eggs were placed in the centre of the box. A large number of eggs have been buried at different depths out-doors where they are under natural conditions of soil pressure and temperature, and the experiments here recorded were made to anticipate the results in the others, which will not be completed till long after this Report is published.

Experiment 30.—Ten egg-masses were placed just one inch below the surface in the centre of a box 4 inches in diameter. The young began to appear January 30th, when it was noticed that every one came up at the side of the box, between the earth and the tin, where there was more or less shrinking of the former from the latter. Upon pressing the earth more firmly around the border, the issuing of the young ceased. Upon examining the eggs March 7th, it was found that they had all hatched. A few of the young were still alive and endeavoring to escape. The rest had died in the effort. They had made no progress upward through the pressed surface, but had pushed horizontally as the looser earth permitted.

Experiment 31.—From 10 egg-masses placed 2 inches beneath the surface the young commenced issuing from the sides as in the preceding Exp., Jan. 31st. None issued directly through the surface of the soil, and none issued after the border was pressed more firmly to the tin. Subsequent examination showed the soil penetrated in devious directions, but none of the insects had reached higher than within ¾ inch of the surface.

Experiment 32.—Ten egg-masses placed 3 inches below the surface. The young began, Jan. 31st, to issue from the sides as in Expts. 30, 31. Upon pressing the ground more firmly around the borders, none afterward issued, and subsequent examination showed that the young had tunneled the earth in tortuous passages toward the sides, and perished there; without reaching nearer than within an inch of the surface in the middle of the box.

Experiment 33.—Ten egg-masses placed 6 inches below the surface. On Feb. 1st the young commenced to issue, as in the preceding Expts., from the side, and continued to do so till the 4th, when the earth was pressed more closely to the tin. None issued afterward. Subsequent examination showed that some had succeeded in working their way upward through the soil to within two inches of the surface; but most had reached the sides and there collected and perished between the tin and the soil.

Other experiments, made in glass tubes where the movements of the insects could be watched, all produced similar results to those above given, and all point to the conclusion that where the newly hatched insect has not the natural channel of exit (described on p. 88) which was prepared by the mother, it must inevitably perish if the soil be moderately compact, unless cracks, fissures, or other channels reaching to the surface, are at hand.

From the above four series of experiments, I would draw the following deductions, which have important practical bearing:

First—Frost has no injurious effect on the eggs; its influence is beneficial rather, in weakening the outer shell.

Second—Alternately freezing and thawing is far less injurious to them than we have hitherto supposed, and tends to their destruction, if at all, indirectly, by exposing them to the free air.

Third—The breaking open of the egg-masses, and exposure of the eggs to the atmosphere, is the most effectual way of destroying them. Hence, the importance of harrowing in the Fall is obvious.

Fourth—Moisture has altogether less effect on the vitality of the eggs than has heretofore been supposed, and will be of little use as a destructive agent, except where land can be overflowed for two or three days at the time when the bulk of the young are hatching.

Fifth—Plowing under of the eggs will be effectual in destroying them, just in proportion as the ground is afterward harrowed and rolled. Its effects will also necessarily vary with the nature of the soil. Other things being equal, Fall plowing will have the advantage over Spring plowing, not only in retarding the hatching period, but in permitting the settling and compacting of the soil; while where the ground is afterwards harrowed and rolled, the Spring plowing will prove just as good, and on light soils, perhaps better.

THE OMAHA CONFERENCE.

At the invitation of Governor Jno. S. Pillsbury, of Minnesota, a conference of the Executives of those States and Territories which most suffer from locust ravages, and of scientific gentlemen interested in the subject, was held at Omaha, Neb., on the 25th and 26th of October last. The following gentlemen were in attendance:

Prof. Cyrus Thomas, of Illinois.
Gov. Samuel J. Kirkwood, of Iowa.
Gov. Thomas A. Osborne, of Kansas.
Gov. Silas Garber,
Ex-Gov. Robt. W. Furnas,
Prof. C. D. Wilber,
Prof. A. D. Williams, and
Hon. Geo. W. Frost, of Nebraska.
Gov. John S. Pillsbury,
Pennock Pusey, and
Prof. A. Whitman, of Minnesota.
Gov. John L. Pennington, of Dakota, and
Gov. C. H. Hardin, and
C. V. Riley, of Missouri.

After an interesting and instructive interchange of opinions and experiences, the following resolutions, reported by the writer on behalf of a committee appointed to express the sense of the Conference, were unanimously adopted:

Your Committee, appointed to draft resolutions expressive of the views of the Conference, would respectfully report as follows:

The Rocky Mountain Locust, or "grasshopper," by its migrations from Territory to Territory and from State to State, destroying millions of dollars' worth of the hard earnings of the Western farmers, crippling the progress of the border States, and retarding the settlement of the Territories, has become a national plague. Its injuries are of such magnitude that no effort should be left untried that will be likely to diminish or avert them.

The work to be done is of a two-fold nature—State and National. From the writings of those who have given the subject careful attention, and from our own past experience, it is quite manifest that the pest in question is not a native of the country south of the 44th parallel or east of the 100th meridian, but that it occasionally overruns the country south and east of these lines, from the extreme Northwest.

There are, therefore, two pressing questions which demand our attention:

1st The best means of fighting the plague as it occurs in the States to which it migrates, but in which it is not indigenous.

2d. The thorough investigation into its habits in its native home, with a view of preventing, if possible, its migrations therefrom.

Toward the elucidation and settlement of the first we have the dear-bought experience of the past few years, and there has already been a large amount of valuable information obtained and published in the proclamation of Gov. Pillsbury, in the report of the special Minnesota commission, appointed in 1875, in the two last entomological reports made to the State of Missouri, by its State entomologist, and in the writings of Prof. Thomas and others. We, therefore, recommend the passage of the following resolutions:

Resolved, That, as much valuable and practical advice has already been published a committee of three be appointed to collect and issue in pamphlet form, as soon as possible, all the more practicable means, based on experience, that we now have any knowledge of, toward the destruction of the insect, whether as it pours down upon us in the winged condition, or as it hatches out in our midst.

Resolved, That the official report of the proceedings of this Conference shall form the prelude to this pamphlet, and that the following recommendations and statement of our views, as to the possibility of contending with the locust shall form a part of said pamphlet. [Here omitted.]

Further, in order to meet the emergency that threatens next Spring, particular stress should be laid on the best means of coping with the eggs and unfledged young that will hatch from them in the Spring of 1877. Among these, we deem as most feasible and best calculated to produce good results, a judicious bounty system; and, as that recommended by Prof. Riley, in his eighth report, is based on the valuable experience gained in 1875, and correctly states the principles that should govern such legislation, we recommend the following:

Resolved, That in our opinion it will be wise and politic for the legislatures of each of the States and Territories most deeply interested in the locust question, to enact a State bounty law, offering a bounty of——per bushel for the collection and destruction of the eggs, and of——per bushel for the destruction of the unfledged insects; that the principles laid down by Prof. Riley for such a law should be kept in view; and that we will use our influence to obtain such a law in our respective States.

Resolved, That we recommend to the several legislatures, that they authorize local taxation for the purpose of systematized effort in the way of ditching, burning, etc., as the local authorities may deem necessary or desirable.

We further invoke our legislatures to adopt such practicable measures as have proved efficacious, and such as further experience may suggest, including the repeal of existing game laws, or such modification of them as will prevent the destruction of birds which feed upon the insects; the prevention of prairie fires until suitable time for the destruction of the young locusts by firing the grass; the encouragement of tree culture for promoting moisture and harboring birds, and such other means as may promote the great end desired.

Resolved, further, That in view of the danger that threatens, it is advisable that, as far as posible, a survey be made of each State during the coming Winter, to ascertain just those portions of each county in which the eggs are most thickly laid, in order to indicate to the county and State authorities the amount of the preparatory work to be done to prevent the threatened injury, and also in order to more thoroughly organize every portion of each State on some plan of securing the intelligent co-operation of farmers and others.

We also recommend the passage of the following resolution:

Resolved, That the Governors of each State and Territory be advised to appoint a commission of one or more competent persons whose duties shall be to visit the counties and towns of each State, and report the facts and observations to the Governors, and also to organize each county and precinct in such manner as may be deemed expedient, and also to appoint in said counties and precincts, suitable persons to receive and distribute such documents and pamphlets, containing general information and means of defence, as will be provided by this Conference, and to report such organizations and names of committees to the respective Governors.

For the solution of the second question, it is the evident duty of the Government to make the proper investigation. We have looked in vain for this aid from our Department of Agriculture, and are satisfied that under its present management, such aid, or any thorough investigations, are not to be expected. We therefore recommend the following:

Resolved, That we deem it the duty of the National Government to make some effort to destroy or counteract this great pest, and thus prevent its injuries.

Resolved, That we believe the first step in this matter should be a thorough investigation into the history and habits of this insect, in its native haunts as well as in the sections visited by it, and the search for all possible means of its extermination, and remedial agencies which may be used against it.

Resolved, That we believe this can be accomplished in the shortest time, at the least expense and most effectually by attaching a special commission for this purpose, to one of the Government Surveys sent out annually to the West; and, therefore, we suggest that the following be added to that clause of the Sundry Civil Appropriation Bill, making an appropriation for the geological and geographical survey of the Territories: "And also the further sum of twenty-five thousand dollars for the purpose of paying the salaries and expenses of a commission to consist of three entomologists and two Western men who have had experience with the locusts, to be appointed by the Chief of said survey, with the consent and approval of the Secretary of the Interior. It shall be the duty of said commissioners to examine into the history and habits of the said locust, and make report thereon, and also suggest such means of destroying them or remedies against them as their investigations shall prove most practicable."

Resolved, That it is our belief that the Signal Service might materially aid such a commission as here demanded, in performing the work, by regular observations made of the time, direction, extent of flights, time of hatching and leaving of the young locusts, etc.; also, by announcing in the daily weather reports the appearance and progress of the swarms; and we ask of Congress to grant to Gen. Myer such additional assistance and means as will enable him to carry out this work.

Resolved, That the President of the Conference be requested to draw up and present to the President of the United States, a letter setting forth the urgent necessity for some action on the part of the General Government in behalf of the sections ravaged, in reference to the invasions of and destruction occasioned by the locusts.

Resolved, That each of the Governors of the following States and Territories, to-wit: Minnesota, Illinois, Iowa, Kansas, Nebraska, Missouri, Colorado, Wyoming, Dakota and Montana, be requested to transmit to their respective delegations a record of these proceedings, requesting them to urge upon Congress speedy action in this matter, in accordance with the recommendations of this Conference.

A committee consisting of John S. Pillsbury, Pennock Pusey, and myself, was appointed to prepare for publication the official report of Proceedings, together with a summary of the best means known for counteracting the evil; and 10,000 copies of a pamphlet of 72 pages were accordingly published last Fall. By being widely distributed, this pamphlet has undoubtedly done much good, and had no small share in bringing about certain much needed State and National legislation.

REMEDIES AND SUGGESTIONS.

As the people in the threatened counties already enumerated (*ante*, p. 67) will, in all probability, go through much the same experience this year, that the farmers of the afflicted counties went through in 1875, there will be a large demand for information as to how best to manage and destroy the young insects. In the hope that this Report will be distributed at an early day, I have thought best to repeat here some of the recommendations made in my last Report, and in the Omaha pamphlet.

Destruction of the Young or unfledged Locusts. — Heavy rolling, where the surface of the soil is sufficiently firm and even, destroys a large number of these newly hatched young, but is most advantageously employed when they are most sluggish and inclined to huddle together, as during the first eight or ten days after hatching, and in the mornings and evenings subsequently. They then drive almost as readily as sheep, and may be burned in large quantities by being driven into windrows or piles of burning hay or straw. They may also be killed with kerosene, and by means of flattened beating implements; wooden shovels being extensively used for this purpose in Europe.

But to protect the crops and do battle to these young locust armies, especially where, as was the case in much of the ravaged country in 1875, there is little or no hay or straw to burn, the best method is ditching. A ditch two feet wide and two feet deep, with perpendicular sides, offers an effectual barrier to the young insects. They tumble into it and accumulate, and die at the bottom in large quantities. In a few days the stench becomes great, and necessitates the covering up of the mass. In order to keep the main ditch open, therefore, it is best to dig pits or deeper side ditches at short intervals, into which the 'hoppers will accumulate and may be buried. Made around a field about hatching time, few 'hoppers will get into that field till they acquire wings, and by that time the principal danger is over, and the insects are fast disappearing. If any should hatch within the enclosure, they are easily driven into the ditches dug in different parts of the field. The direction of the apprehended approach of the insects being known from their hatching locality, ditching one or two sides next to such locality, is generally sufficient, and where farmers joint hey can construct a long ditch, which will protect many farms.

With proper and systematic ditching early in the season, when the insects first hatch, everything can be saved. When water can be let into the ditches so as to cover the bottom they may be made shallower, and still be effective.

A ditch three feet wide, unless correspondingly deep, will be more apt to permit the escape of the insects, when once in, than a narrower one. In hopping, the more perpendicular the direction the insects must take, the shorter will be the distance reached. Of course the wider the ditch, if it be correspondingly deep, the more effectual will it prove. In exceptional cases, when the locusts are nearly full grown and the wind is high so as to assist them, even the two-foot ditch loses much of its value.

Next to ditching the use of nets or seines, or converging strips of calico or any other material, made after the plan of a quail net, has proved most satisfactory. By digging a pit, or boring a post auger hole, three or four feet deep, and then staking the two wings so that they converge toward it, large numbers of the locusts may be driven into the pit after the dew is off the ground. By changing the position of this trap, much good can be done when the insects are yet small and huddled in schools; but all modes of bagging, netting, crushing with the spade or other flat implements and burning, which can be employed to good advantage when the insects first begin to hatch, become comparatively useless when they begin to travel in concert over wide stretches of land. The same may be said of all the mechanical contrivances to facilitate the destruction of the insects; they are useful if used in concert in a given neighborhood soon after the young hatch, but subsequently do not compare to ditching.

When the insects are famishing, it is useless to try and protect plants by any application whatever, though spraying them with a mixture of kerosene and warm water is the best protection yet known, and will measurably answer when the insects are not too numerous or ravenous.

The best means of protecting fruit and shade trees deserves separate consideration. Where the trunk is smooth and perpendicular, they may be protected by whitewashing.

The lime crumbles under the feet of the insects as they attempt to climb, and prevents their getting up. By their persistent efforts, however, they gradually tear off the lime and reach a higher point each day, so that the whitewashing must be often repeated. Trees with short, rough trunks, or which lean, are not very well protected in this way. A strip of smooth, bright tin answers even better for the same purpose. A strip three or four inches wide brought around and tacked to a smooth tree will protect it; while on rougher trees a piece of old rope may first be tacked around the tree and the tin tacked to it, so as to leave a portion both above and below. Passages between the tin and rope or the rope and tree can then be blocked by filling the upper area between tin and tree with earth. The tin must be high enough from the ground to prevent the 'hoppers from jumping from the latter beyond it; and the trunk below the tin, where the insects collect, should be covered with some greasy or poisonous substances to prevent girdling. This is more especially necessary with small trees; and kerosene or whitewash having Paris green mixed with it will answer as such preventives.

One of the cheapest and simplest modes is to encircle the tree with cotton batting, into which the insects will entangle their feet, and thus be more or less obstructed. Strips of paper covered with tar, stiff paper tied on so as to slope roof-fashion, strips of glazed wall paper, thick coatings of soft soap, have been used with varying success; but no estoppel equals the bright tin; the others require constant watching and renewal, and in all cases coming under my observation some insects would get into the trees so as to require the daily shaking of these morning and evening. This will sometimes have to be done when the bulk of the insects have become fledged, even where tin is used; for a certain proportion of the insects will then fly into the trees. They do most damage during the night, and care should be had that the trees be unloaded of their voracious freight just before dark.

Finally, most cultivated plants may be measurably protected from the ravages of these young by good cultivation and a constant stirring of the soil. The young have an antipathy to a loose and friable surface, which incommodes them and hinders their progress; and they will often leave such a surface for one more hard and firm.

Hogs and poultry of every description delight to feed on the young locusts, and will flourish where these abound when nothing else does. Our farmers in the threatened counties should provide themselves with as large a quantity as possible of this stock. Where no general and systematic efforts have been made to destroy either the eggs or the young locusts, and it is found that, as Spring opens, these young hatch out in threatening numbers, the intelligent farmer will delay the planting of everything that cannot be protected by ditching until the very last moment, or till the insects become fledged—using his team and time solely in the preparation of his land In this way he will not only save his seed and the labor of planting, and, perhaps, replanting, but he will materially assist in weakening the devouring armies. Men planted in 1875, and worked with a will and energy born of necessity, only to see their crops finally taken, their seed gone, and their teams and themselves worn out. The locusts in the end destroyed every green thing, until finding nothing more, they began to fall upon each other and to perish. This critical period in their history would have been brought about much earlier if they had not had the cultivated crops to feed upon; and if by concert of action this system of non-planting could at first have been adopted over large areas, the insects would have been much sooner starved out and obliged to congregate in the pastures, prairies and timber. Moreover the time required for early planting and cultivation, if devoted to destroying the insects after the bulk of them hatch out toward the end of April, would virtually annihilate them.

Too much stress cannot be laid on the advantages of co-operation and concert of action, to accomplish which ought not to be difficult, with our present Grange system. To insure concert of action, it would be well to authorize the supervisors of each school district to call out every able-bodied man and oblige him to work in a general system of destruction as soon as the bulk of the young insects have hatched, and the same would apply equally as well to the destruction of the eggs.

Many of the wheat fields have been injured principally on the outside. I would recommend to plow up such injured portions and sow to rye. Finally, though insisting on ditching and the digging of pits, as, all things considered, the best and most reliable insurance against the ravages of the young locusts; I would urge our farmers to rely not on this means alone, but to employ all the other means recommended, according as convenience and opportunity suggest.

LEGISLATION.

It is a gratifying indication of the increasing appreciation of economic entomology that, while three years ago the mere suggestion to enact laws for the suppression of injurious insects would have been, and was received by our legislators with ridicule; yet, during the Winter of 1876–7, several States have seen fit to pass acts that have for object the destruction of this locust, or the relief of the suffering and destitution it so often entails. Even Congress has at last felt the necessity of doing something to mitigate this national evil, and at the last hour, made an appropriation to defray the expenses of a commission, whose duty it shall be to make a thorough investigation into the matter. I give below the State laws that have been passed:

MISSOURI.—AN ACT TO ENCOURAGE THE DESTRUCTION OF GRASSHOPPERS.

Be it enacted by the General Assembly of the State of Missouri, as follows:

SECTION 1. Any person who shall gather, or cause to be gathered by any person in his employ, eggs of the Rocky Mountain locust or grasshopper, at any time after they are deposited in the earth in the autumn of any year, and before they are hatched the following spring, shall be entitled to a bounty of five dollars for each and every bushel of eggs thus gathered, or for any quantity less than one bushel, bounty at the same rate, to be paid, one-half by the State and one-half by the county in which they are gathered.

SEC. 2. Any person who shall gather, collect and kill, or cause to be so collected and killed, young and unfledged grasshoppers in the month of March, shall be entitled to a bounty of one dollar for each bushel, and for the month of April, fifty cents per bushel, and for the month of May, twenty-five cents per bushel, to be paid in the same manner as in the preceding section.

SEC. 3. Any person claiming bounty under this act, shall produce the eggs and grasshoppers thus gathered or killed, as the case may be, before the clerk of the county court in which such eggs or grasshoppers were gathered or killed, within ten days thereafter, whereupon said clerk shall administer to such person the following oath or affirmation: You do solemnly swear (or affirm, as the case may be,) that the eggs (or grasshoppers, as the case may be,) produced by you, were taken and gathered by you, or by person or persons in your employ, or under your control, and within this county and State.

SEC. 4. The clerk shall forthwith destroy said eggs by burning the same and give to the person proving up the same under his hand and seal, a certificate setting forth in a plain handwriting, without interlineation, the amount of eggs or grasshoppers produced and destroyed by him, and the name and residence of such person producing the same, which certificate shall be in the following form:

STATE OF MISSOURI, }
COUNTY OF.................. }

This is to certify that .... in the county of .... A. B., did this day prove before me that he had gathered, or caused to be gathered, ... of eggs, ... grasshoppers, and is entitled to the sum of .... dollars, and .... cents.

Given under my hand and seal of my office, this .... day of .... A. D. 18......

.... A. B., Clerk County Court.

Which certificate shall be received and taken by the collector of revenue of the county in which the same was given, and such collector shall be allowed pay out of the county and State Treasury, one-half from each.

SEC. 5. Such clerk shall keep a register of all such certificates given by him, in a book which he shall keep for that purpose, in which he shall note down every certificate granted by him, the number and amount, and to whom granted, and transmit a certified copy of such register, under the seal of the court, to the Treasurer of the State, who shall not allow and pay any certificate, which does not correspond with such register.

SEC. 6. Such clerk shall receive for his services as aforesaid, one dollar for such certified copy of the register, and the regular fee for the certificate and seal, and ten cents for each certificate granted under this act, all to be paid out of the treasury of his county.

SEC. 7. As the object of this act is the rapid destruction of the locust the ensuing spring, it shall take effect and be in force from and after its passage.

Approved February 23, 1877.

This act is drawn up after the form recommended in my last Report, and reprinted in the Omaha pamphlet. Section 3, requiring persons claiming bounty, to carry from all parts of the county, the eggs or young insects collected, is defective, as those living near the county seat will have most advantage and inducement. It would be better, as I suggested years ago, to empower the Township Trustee, or the Street Commissioner, to receive and measure the eggs or young insects, and to issue certificates setting forth the number of bushels destroyed—the certificates to be filed with the County Clerk. But even with this slight defect, the act will have a beneficial effect in the counties subject to locust ravages:

KANSAS—AN ACT TO PROVIDE FOR THE DESTRUCTION OF GRASSHOPPERS AND TO PUNISH FOR VIOLATION OF THIS ACT.

Be it enacted by the Legislature of the State of Kansas:

SECTION 1. That the township trustees of the different townships, and the mayors of cities which are not included in any township of any county within this State, are hereby authorized and it is made their duty, when so requested, in writing, by fifteen of the legal voters of the township or city, to issue orders to the road overseers of the different road districts within their respective townships or cities, to warn out all able bodied males between the ages of twelve and fifty years within their respective districts for the purpose of destroying locusts or migratory insects.

SEC. 2. It shall be the duty of road overseers, immediately after receiving said orders, to proceed at once to warn out all persons liable under section one of this act, giving notice of the time and place of meeting, and the tools to be used, and the kind of work expected to be performed, and all work shall be done and performed under the direction of the road overseers.

SEC. 3. Any persons over eighteen years of age warned out as is provided in this act, may pay the road overseer the sum of one dollar per day for the time so warned out, and in case any persons shall fail to perform labor under this act or paying the sum of one dollar when so warned out, shall be adjudged guilty of a misdemeanor, and on conviction, shall be fined the sum of three dollars for each day so failing or refusing, and the moneys so collected shall be expended by the road overseer in the destruction of grasshoppers in their respective road districts.

SEC. 4. For the purpose of carrying out the provisions of this act the road overseer is authorized to enter upon the premises of any person lying within the township where such order of the township trustee is in force, with a sufficient number of hands and teams to perform such labor as he may deem necessary for the public good.

SEC. 5. It shall be the duty of the Secretary of the State Board of Agriculture, immediately after the passage of this act, to compile in circular form all information relating to the manner and means heretofore used for the extermination of grasshoppers, and send at least ten copies of the same to each township trustee in the State.

SEC. 6. This act shall take effect and be in force from and after its publication once in the Commonwealth.

Approved March 6, 1877.

AN ACT PROVIDING FOR A CONCERT OF ACTION BY SENATORIAL DISTRICTS FOR THE DESTRUCTION OF GRASSHOPPERS.

Be it enacted by the Legislature of the State of Kansas :

SECTION 1. That in any senatorial district in the State of Kansas, where trouble is anticipated from the ravages of young grasshoppers, in the year 1877, and any subsequent year thereafter, it shall be lawful for the counties in said senatorial district to co-operate together in the way and manner herein provided, for the destruction of the same.

SEC. 2. The chairman of the board of county commissioners in the county having the largest number of inhabitants in a senatorial district, where two or more counties form said district, may notify the chairman of each of the boards of county commissioners of the remaining counties in said district, of the time and place when the chairmen of the several boards of commissioners of the respective counties forming said senatorial district shall hold a joint meeting.

SEC. 3. At such meeting two of their number shall be chosen to act as chairman and secretary, and the proceedings of the meeting shall be published in all the newspapers printed in the senatorial district.

SEC. 4. Said meeting shall designate the manner of procedure by road overseers, and what day or days the young grasshoppers should be driven from the cultivated land on the unburnt prairie or places of destruction, and shall also designate on what day or days the grasshoppers shall be destroyed, by burning or otherwise, in said senatorial district, giving at least ten days' notice of the same by publishing in the newspapers of the said district.

SEC. 5. The board of commissioners of each county shall notify the road overseers of said county of the time fixed upon by the joint meeting for the driving and burning, or destroying by other means, of the grasshoppers in the district; said notice to be given to said overseers as soon as practicable after the same shall have been determined by the joint meeting.

SEC 6. Said road overseer shall immediately notify the residents of his road district of the time designated and the manner of procedure, in order to carry out the provisions of this act. He shall also specify what tools or implements will be required of each resident in performing the labor required of him; and such notice may be enforced the same as in the acts authorizing road overseers to warn out the residents to perform road labor; and a refusal shall subject such persons refusing to the same penalties as are provided by law in such cases.

SEC. 7. The road overseers shall direct the manner of performing the labor, and have the supervision of the same, and shall keep a list of the names of those who shall perform labor, and shall certify the number of days' work performed by each, and shall place such certified list in the possession of the board of county commissioners of his county.

SEC 8. It shall be lawful for two or more senatorial districts to co-operate together under the provisons of this act, on a basis of action which they may agree upon.

SEC. 9. This act shall take effect and be in force from and after its publication in the daily *Commonwealth.*

Approved March 7, 1877.

Both these acts look to compulsory work and concert of action, and in these respects are preferable to bounty acts, and will, without doubt, be productive of more good to the community at less expense to the State. The objects of the two acts should, I think, have been combined in one.

MINNESOTA.—AN ACT TO PROVIDE FOR THE DESTRUCTION OF GRASSHOPPERS AND THEIR EGGS.

Be it enacted by the Legislature of the State of Minnesota:

SECTION 1. There shall be paid by this State, out of any moneys in the treasury thereof, not otherwise appropriated, to any person or persons living within any of the counties in said State afflicted by grasshoppers, the following bounties for catching and destroying of the same, and the destruction of their eggs.

SEC. 2. The sum of one dollar per bushel for grasshoppers caught previous to the twenty-fifth day of May next. The sum of fifty cents per bushel from the said twenty-fifth day of May to the tenth day of June. The sum of twenty-five cents per bushel from the said tenth day of June to the first day of July, and twenty cents per bushel from the said first day of July to the first day of October next.

SEC. 3. There shall also be paid in the same manner, the sum of fifty cents per gallon for any and all grasshopper eggs taken and destroyed by any person or persons.

SEC. 4. There shall be appointed by the Governor a competent person in each township in the several counties so afflicted by grasshoppers, who shall be a resident of the township for which he shall be appointed, to receive, measure and destroy the grasshoppers and their eggs delivered to him by any person or persons catching and taking the same, which said person so appointed shall take and subscribe an oath for the faithful discharge of his duties, which oath, together with the certificate of appointment, shall be filed in the office of the county auditor, and he shall receive as compensation for his services such sum as the county commissioner may determine, to be paid out of the funds of the county, and in case of necessity, when he cannot perform the duties of his office, said measurer shall have authority and be empowered to appoint a suitable and competent person his assistant, which assistant shall be required to take and subscribe the same oath and be subject to the same penalties as the said measurer.

SEC. 5. The person receiving and measuring the grasshoppers and their eggs as aforesaid, shall measure and immediately and effectually destroy the same, and keep an exact account of all the grasshoppers and their eggs received by him and the names of the persons delivering the same, and shall issue a certificate for the amount of grasshoppers and their eggs to the person delivering the same. And he shall, at the end of each week after commencing to receive and measure the same, and on the second day of June, on the eleventh day of said month, on the second day of July, and on the second day of October next, make a report to the county auditor of all the grasshoppers and their eggs measured by him, the number of certificates issued, and the names of the persons to whom he issued the same; and the county auditor shall examine the same and file it in his office, which report shall be subject to public inspection; and the county auditor shall, at the end of each week after he shall have received the first of said reports, transmit a copy of the said reports, to the Governor, who shall, as soon as the sum hereby appropriated shall have been expended in the payment of said bounties, notify all persons interested therein of such fact by a publication of such notice in some newspaper printed and published at the city of Saint Paul, in said State of Minnesota, for three successive days.

SEC. 6. For a failure on the part of said measurer to perform any of his duties under this act, or for any mismeasurment of such grasshoppers and their eggs, he shall be deemed to be guilty of a misdemeanor, and be subject to pay a fine of not less than ten dollars nor more than one hundred dollars, or be imprisoned in the county jail for a term of not less than thirty nor more than ninety days, in a suit or proceeding to be prosecuted in the name of the State of Minnesota, in the same manner as is provided by law in other cases of misdemeanor.

SEC. 7. Upon the presentation of such certificate to the county auditor, he shall issue a certificate to the person entitled thereto for the amount due him, (a form of which certificate shall be furnished by the State Auditor,) and shall make an order upon the State Auditor for the amount thereof, and the State Auditor shall draw his warrant upon the State Treasurer for that amount, in favor of the parties holding said certificates, which shall be paid by the State Treasurer on presentation: *Provided*, That all certificates presented to the county auditor for payment shall be by him filed and preserved in his office, and he shall present such certificates to the board of county commissioners, who shall audit the same in the manner now provided by law for auditing accounts against counties; and no money shall be drawn from the State treasury until such certificates have been audited and allowed in the manner herein provided. And that no money shall be paid under the provisions of this act at any time prior to the fifteenth day of July, A. D. eighteen hundred and seventy-seven, and that the money hereby appropriated shall only apply to certificates duly made and filed with the Auditor of State on or before said day; that at the time after the State Auditor shall ascertain the total amount of all claims and certificates so filed, and if the same shall exceed in amount the sum of one hundred thousand dollars, then the said claims shall be paid pro rata, and no other or greater amount than said sum of one hundred thousand dollars shall ever be paid under the provisions of this act: *And provided further*, That if the amount hereby appropriated is not sufficient to pay the certificates in full, the balance shall be paid by the counties respectively, according to the amount due on said certificates as issued by such county.

SEC. 8. Every male inhabitant of the several townships in the said afflicted counties, being above the age of twenty-one years and under the age of sixty years, excepting paupers, idiots and lunatics, shall be assessed by the board of supervisors of said township to work one day in each week in said township, during the period hereinbefore mentioned, for the paying of bounties for the purpose of catching and destroying grasshoppers and their eggs, for five weeks from the time said grasshoppers shall become large enough to be taken; and the amount of work to be so assessed shall not exceed five days in all.

SEC. 9. The supervisors aforesaid shall make a list of the names of all persons against whom said tax shall have been assessed, and place in a column opposite each name on said list, the amount of labor assessed against such person, and shall direct the town clerk to make a certified copy of each list, after which the town clerk shall deliver the several copies to the respective overseers of the highways of said townships.

SEC. 10. The overseers of highways shall give at least two days' notice to all persons assessed to work as aforesaid, living within the limits of their respective districts, of the time and places where and when they are to appear for that purpose, and with what implements.

SEC. 11. Every person liable to work, as provided for in this act, may commute for the same at the rate of one dollar per day, in which case such commutation money shall be paid to the chairman of the board of supervisors, to be applied and expended by him for the destruction of grasshoppers and their eggs, and he shall be authorized and required to hire and engage some suitable and efficient person to work in the place of said person so commuting, and to pay them the sum of one dollar per day for his services; and every person intending to commute for his assessment shall, within five days after he is notified to appear and work as aforesaid, pay the commutation money for the work required of him by said notice, and the commutation shall not be considered as made until such money is paid.

SEC. 12. Every person so assessed and notified, who shall willfully neglect or refuse to commute or work as provided by this act, shall be guilty of a misdemeanor, and shall, on conviction thereof, be liable to pay a fine of not less than two dollars nor more than ten dollars, or by imprisonment in the county jail not more than ten days, or both, in the discretion of the court, in a suit to be prosecuted in the name of the State of Minnesota, in the same manner as is provided by law for prosecutions of misdemeanors.

SEC. 13. There shall be appropriated, out of any moneys in the treasury of this State, not otherwise appropriated, for the purpose of carrying out the provisions of this act, the sum of one hundred thousand dollars.

SEC. 14. The board of county commissioners of any county in this State afflicted by grasshoppers, shall have the right, if, in their judgment they see fit, to employ one or more persons in each township in said county with such implements or mechanical contrivances as may prove most efficient to destroy the grasshoppers, from the first day of April to the first day of August in each year, paying such persons either by the day or a specified sum for the amount captured and destroyed. The compensation of such person shall be paid out of the general fund of the county: *Provided further*, That parties employed and paid by the county commissioners shall not receive any other or further compensation under the provisions of this act.

SEC. 15. This act shall take effect and be in force from and after its passage.

Approved March 1, 1877.

More complicated than the others, this Minnesota act has certain special features which are intended to meet the peculiar emergency in that State. Yet I do not think the act is as clear or will prove as effectual as the first Kansas act. In addition to this bounty act, the Minnesota Legislature passed another appropriating $75,000 for the purchase and distribution of seed grain to the sufferers from locust injuries.

If the States of Iowa, Nebraska, Colorado and Texas would enact similar laws, appropriate to their respective requirements, there would be such combined slaughter of the insects that in all the more thickly settled portions of the country subject to invasion, they would be virtually annihilated before they acquired wings. It is by some such uniform and concerted warfare, calculated to prevent the insects that hatch out in said country from flying back to restock the Northwest, that the people may hope to measurably conquer the foe and lengthen the periods of immunity between the invasions.

AREA IN WHICH EGGS WERE LAID.

The locust invasion of 1876 was remarkable for the very large area in which eggs were laid. This was almost coextensive with the area invaded and is indicated in the map (Fig. 16), though the counties of Murray, Cottonwood, Watonwa, Brown and parts of the adjacent counties, in Minnesota, which are there included, should, as already stated (*ante*, p. 62) be excepted.

The eggs are most thickly laid in the eastern, more settled and more generally cultivated portion of the belt, and less thickly in the thinly settled prairie country. Another noticeable feature of this invasion was, that, from Minnesota to the Gulf, egg-laying continued till the females were buried in the first snows or killed by the first severe frosts. Far into November and after the thermometer had frequently fallen several degrees below the freezing point, I found them rousing from the night's benumbing cold, and, under the increasing warmth of the sun toward noon, laying in exposed and sunny places. Hiding in the dry grass or under other shelter where they were unseen during the cooler parts of the day, one might pass through a country at such hours without suspecting their presence; while at noon they would start at every foot step. And only the day before the last one was buried beyond recovery by a severe snow storm, I found females not only laying, but many of them having eggs in the ovaries that were yet quite small—thus showing that they prematurely perished by winter's chilling blasts.

CONDITION OF THE EGGS.

The farmers of the West have been deeply interested in the condition of the eggs during the Winter, and have naturally hoped that, as the season advanced, the vitality of these eggs might in some way or other be impaired. I have, from time to time, examined eggs from many different localities, and the following inquiries, with my answers, as published in the *Rural World* at the time, will serve to indicate the generally sound condition they were in, up to the first week in February.

I send you, by to-day's mail, specimens of grasshopper eggs procured on my farm, as follows: Specimen No. 1 was procured in house yard, where exposed to constant tramping; No. 2 from loose soil, in an exposed position; No. 3 from a foot-path, on south side of hedge. Please examine and report upon condition of the several specimens, and oblige. DR. W. F. RUTBOTTOM.

RHEA'S MILL, COLLIN CO., TEXAS, January 16.

All three lots were sound, and the embryon so far advanced that a week's mild weather would hatch the young.—[Since this was written they have all hatched.]

I have for sometime past been carefully examining the deposits of locust eggs in this vicinity, and find them nearly addled, very few indeed being found, and those only upon sod, in which segmentation cannot be detected with the aid of a small magnifying glass. Other observers here report the same condition, and we are satisfied that no fears need be entertained of damage from the young brood, provided the addled eggs do not hatch. Can the development within the egg be arrested, and yet go on upon the return of proper conditions? Some of us have been led to fear that such might be the case, by the plump, fresh appearance of the little rascals, after repeated freezing and thawing. Your answer to the above question will be thankfully received by many of us here, who depend upon our farm crops for a living. A. ROBERTS.

LINCOLN, NEBRASKA, January 13, 1877.

It is difficult to get at what Mr. Roberts exactly means. Eggs once "addled" of course never hatch, but "segmentation" does not indicate an addled condition. On the contrary, it indicates development. The best way to get positive information is to send me specimens.

Herein find eggs of Rocky Mountain Locust. What is their condition?

LAMAR, Barton county, Mo. A. A. DYE.

The eggs are below the average size, and part of them dead. The probabilities are that few of them will hatch.

I am very much interested in this "hopper question," as great quantities of eggs were deposited in this section last Fall. I have read carefully the proceedings of the Conference in Omaha. Also, some of your articles in the New York *Tribune;* but find nothing on the point of what advancement the eggs make towards hatching in the Fall. Of all the egg sacks examined (which were not addled), the eye of the hopper could be discerned through his particular covering; and, on removing the covering, the hind legs could be raised clear of the body, by the aid of a pin. The question is, after making that advancement, will they live through the Winter and hatch out in the Spring? S. C. BASSETT.

GIBBON, NEB., January 10, 1877.

Yes! I have had them in that advanced condition; kept them till the first of the year; then brought them into a hatching temperature, and they hatched.

I have just been reading the report of your meeting at Omaha, on the grasshopper, and as I live in this great grasshopper country, and am a firm believer in your treatise and sayings on the pest, I have some questions to ask. I made some observations last Fall, and up to the time the ground froze up, of their eggs; and would ask, if young eggs will hatch that were so far advanced that, in breaking open the egg-sack, you could distinguish the hopper's eyes and the shape of his legs? Now, it seems to me, that eggs that far advanced must certainly be destroyed by the cold weather we have had of late. Am I correct? By answering this, you will confer a favor upon one who is greatly interested. It is the prevailing opinion of most of the people that we won't be hurt much in the Spring. Thus far there has been very little prairie burned, and am in hopes by your advice and others, who understand the nature of the hopper, to give them a warm reception in the Spring, if they hatch to any great number.

MINNEAPOLIS, Ottawa county, Kansas. M. A. ARNOTT.

I would not dare to give hope without examining specimens. Send some along. Little hope can be built on the advanced condition of the eggs. Better prepare to give the young fellows a warm reception in Spring.

I have sent you by mail to-day some hopper eggs, taken out of the ground on December 25. They have been in my store ever since. I have some eggs that have never been outside my store since September, and also some taken out of the ground the same day that the ones I send you were. I am watching them as closely as I can. WM. C. RALLS.

LE SEUER, Minn.

The eggs are very small, as the pods also, and fully one-half of the eggs are addled.

I wish your opinion in relation to a question under discussion here, viz: Will the grasshoppers, that are now in a fleshy or larval state, hatch? The eggs that were laid during the earlier part of the season that the 'hoppers were here, have developed into a larval state, and many persons claim that, because of that development, they will perish by the Winter. My opinion is, that they are all right and will hatch. What do you say. The later laid eggs are yet in a fluid state.

COUNCIL BLUFFS, Iowa. H. C. RAYMOND.

I am, as will be seen above, of your opinion.

I have to-day been examining grasshopper eggs, and where they are thickest I have found worms or larvæ like the enclosed. Are they the white worms that were in the egg cocoons last Fall, or are they something else? The grasshopper eggs seem in good condition; but we are having very warm weather now, and the frost is coming out of the ground. The weather is much like that we had in '67–8. I found no worms in the cocoons with the eggs. WM. DUNN.

SYRACUSE, Otoe county, Neb., Feb. 1, 1877.

The locust eggs are yet sound, but I have some hope that the recent very warm weather, if succeeded by severe cold, will cause the death of a large portion. [The grubs preying on the eggs were the Ichneumon larva described on p. 96, Fig. 24].

Friend Clarkson, agricultural editor of the Iowa *State Register*, recommends that grasshopper eggs be sent you for examination, and I send by mail to-day, in a tin box, some eggs which have been taken from the ground under the following conditions: As you will find, I have packed them in layers in the box, with paper between. The top layer was taken from black loam on a piece of ground apt to keep dry—that is, well drained—and have never been completely thawed since frozen in the beginning of Winter. The middle layer was taken from sand, and has repeatedly been frozen and thawed out—the water from thawing snow running over and completely saturating the sand daily for some days. The bottom layer is from low land, which was submerged in five feet of water for ten days after they were deposited in the Fall, the ground remaining muddy till frozen, afterwards covered with snow; the continued thawing and evaporation of the last few days have removed the snow and left the surface for two inches in depth thawed and dry. For the past few days we have had it warm in day time, but freezing at night. The place is in Adams county, ninety miles east of Council Bluffs, and forty miles north of the Missouri line.

WM. THOMPSON.

MT. ETNA, Adams County, Iowa, January 30, 1877.

The eggs from all three of the different positions are so little advanced in development that it is impossible to say positively that they are all sound. The liquids have scarcely begun to thicken. So far as I feel warranted in giving an opinion, I should say that they are all sound—those of the third batch only, giving some evidence of injury by the weakening of the integument. [All hatched since.]

By this mail I forward to you one box of the grasshopper eggs. Are they in a good state of preservation, and will they hatch in the Spring if everything hereafter is favorable?

Enclosed I hand you an extract from the *Interior*. You will see the question raised there as to whether an egg can be partially hatched, as these are, and then the process delayed for a long time, and afterwards resume the work and go on to completion. All our people here regard this proposition with considerable doubt. In fact, they deny that such a thing can be done. I should infer that you hold that these eggs will hatch, notwithstanding the interruption. Will you please enlighten us fully as to why this is thus?

HUTCHINSON, KANSAS, January 29, 1877. J. B. SHANE.

The article alluded to by Mr. Shane closes with the following editorial remarks:

Without arrogating to ourself any special wisdom on the subject, but reasoning from analogy only, should decide that in the case of the eggs referred to by Major Shane—and in fact, all the eggs in the country in the same condition—incubation has been arrested, and that once arrested, it has ceased forever. In all life that emanates from an egg (and what life does not, except the vegetable?) when its development is arrested during incubation, it is a permanent paralysis; in other words, it is death. We say that, analogically, this should be so, but we may be wrong.

The advanced development of the locust embryo in the eggs sent by Mr. Shane, argues nothing but very early hatching as soon as Spring opens. Their vitality is unimpaired, as Mr. Shane may soon prove by bringing them into a warm room. I have had such forward eggs hatch the present Winter after various periods of freezing.

Enclosed, please find eggs of Rocky Mountain Locust. They were taken on my farm, on southeast quarter of section 19, township 28, range 27, county of Lawrence, and State of Missouri.
February 2, 1877. W. R. GOODMAN.

Fully ten per cent. of the eggs are dead and more or less decomposed. As in other instances from Missouri, a number of the masses, as also the eggs, are far below the average size, and, compared with those received from the farther West and South, are evidently lacking in vitality. They were doubtless the last eggs laid, just before Winter, and when the insects were nearly exhausted.

I, like many others, desiring some information regarding our coming crop of *Grasshoppers*, wish to ask a few questions on the subject. In examining the eggs late last Fall, I found many formed so one could see the eggs and form, and upon recently examining them, I find they are in the same condition as three months ago. Now, will those thus formed pass through the winter and hatch *in the Spring*, or will they be destroyed? Other eggs are in the same state, for all I can see, as when deposited. Now, is it likely the whole crop will mature in the Spring? Please inform me regarding it. Any information you can give on the subject will be thankfully received by myself and many others, who feel afraid of the results of the coming Spring, with the great amount of eggs deposited.
PLYMOUTH, Nebr., Jan. 21, 1877. J. E. ROE.

There is no doubt but that the eggs will mature under ordinary Spring conditions. The fact of some of them being so much more advanced than others, will not, in the least, interfere with their hatching.

I send you this day a box of locust eggs packed in earth. Please tell us whether they will hatch?
WICHITA, Kans., Feb. 2, 1877. A. B. ARMENT.

The eggs were all sound and yet in the fluid state.

Eggs received and examined almost every day during February and up to March 10th, were, like those examined earlier in the season, in the main sound. A certain proportion of the young hatched during the mild Fall weather we had in October, while the unusually warm weather that occurred the last ten days of January and forepart of February caused still larger numbers to hatch, not alone in the southern portion of the territory occupied, but even as far north as Dakota. The young that thus prematurely hatched perished by subsequent frosts, for I have proved that while the eggs are unaffected by intense freezing, the young insects are killed at 15° F. As the Winter was in some respects remarkable, as well for the warm weather which thus caused the eggs to hatch, as for the many and sudden changes of temperature; and as the eggs have not been injured thereby to any appreciable extent up to the date of this writing, I will place upon record, in this connection, the thermometrical observations made at St. Louis from November 15, 1876, to March 10, 1877:

Temperature at St. Louis, Mo., of Winter of 1876–7.

1876.	Max.	Min.	Mean.
November 15	41	30	37
16	44	35	39
17	47	40	44
18	47	25	34
19	36	22	32
20	45	31	38
21	47	32	37
22	42	23	35
23	45	31	36
24	51	32	41
25	47	31	40
26	38	30	34
27	45	31	39
28	39	23	28
29	33	27	29
30	27	15	16
December 1	20	4	14
2	24	5	16
3	29	12	23
4	34	24	30
5	45	24	34
6	47	33	38
7	47	31	39
8	40	3	15
9	11	—5	5
10	37	9	31
11	55	28	44
12	60	36	48
13	50	38	42
14	38	18	27
15	45	12	36
16	44	4	12
17	27	13	20
18	22	2	16
19	37	18	28
20	43	23	33
21	43	23	34
22	37	20	26
23	24	13	19
24	19	11	15
25	21	13	18
26	21	13	18
27	24	15	21
28	26	17	21
29	19	10	14
30	21	4	15
31	34	17	24
1877.			
January 1	24	13	14
2	21	8	15
3	26	11	21
4	42	19	33
5	42	29	36
6	43	32	37
7	35	13	21
8	13	—4	7
9	28	1	19
10	35	21	31

1877.	Max.	Min.	Mean.
January 11	52	32	40
12	32	14	19
13	27	10	22
14	34	22	31
15	43	23	33
16	23	9	18
17	40	20	35
18	46	35	42
19	50	39	45
20	46	21	22
21	37	19	32
22	37	23	26
23	32	10	24
24	31	19	26
25	48	22	36
26	51	32	39
27	50	31	41
28	57	33	47
29	57	38	49
30	65	48	57
31	66	53	59
February 1	69	50	59
2	56	44	49
3	48	35	37
4	46	32	39
5	40	28	33
6	49	34	41
7	53	38	46
8	47	36	42
9	50	33	44
10	58	37	48
11	58	42	52
12	52	29	32
13	36	28	33
14	44	30	38
15	53	31	44
16	47	38	40
17	50	34	42
18	66	34	53
19	58	34	37
20	48	27	39
21	65	34	51
22	53	41	47
23	44	33	38
24	35	29	32
25	33	28	31
26	43	28	37
27	48	28	40
28	50	32	43
March 1	47	39	43
2	47	37	39
3	49	18	29
4	32	14	26
5	40	26	34
6	55	30	46
7	57	36	47
8	55	18	23
9	23	9	18
10	41	16	31

From meteorological data obtained at Lawrence, Kansas, and furnished by Prof. F. H. Snow, and from reports from many other parts of the country, it is evident that the high temperature of January and February was general throughout the country between the Rocky Mountains and the Mississippi, reaching its acme on the 18th of the latter month. Dr. Engelmann found the first maple in bloom, in St. Louis, on the 19th of February, and has no notes of such early blooming in the past forty years during which he has recorded observations.

PROSPECTS FOR 1877.

A large number of the readers of this Report would feel sadly disappointed were I to conclude this review of our last locust invasion without expressing an opinion as to the future prospects. To give an opinion as to the happenings of the future is somewhat hazardous where there are so many possible contingencies that are altogether beyond man's ken; yet one who is careful in his expressions and statements need never hesitate to advance them. With a reputation at stake, I have not hesitated to do so in the past, and wherever I have felt warranted in making a positive prediction, or in giving an unqualified opinion, subsequent events have justified the same. I will, therefore, give my views of the prospects for the year 1877, as they appear from the condition of things at this writing (March 10th); premising only that, in forecasting future events in connection with this insect, I would rather err on the bright than the gloomy side.

The area over which eggs have been laid is, as we have have already seen, unusually large. It was quite generally noticed that the females were less particular than is their wont in choosing clear and sunny spots for purposes of oviposition, and, after careful consideration of the subject, I should say that, at the lowest estimate, two out of every one hundred acres throughout the area indicated by the heavier lines in my map (Fig. 16) are thickly supplied with eggs, and by this I mean mean that the eggs will average 3,000 to the square foot. In other words, throughout this whole country the southern slopes, sandy, gravelly, and other bare spots, roads, paths, etc., in which the females prefer to lay; compare, on an average, as 2 to 100 with the northern slopes, timber, rank prairie, moist and recently cultivated lands, which are generally avoided. At these low estimates there would, under favorable circumstances, enough young locusts hatch out to devour everything green, not only in the area stated, but over the whole United States, were they evenly disseminated throughout the country. We have already seen that the bulk of the eggs yet remain sound, and, notwithstanding such as have been destroyed by natural enemies and all other causes, and such as have prematurely hatched, those yet to hatch will give birth to locusts enough, under ordinary conditions of weather, to lay waste the earth and render it as bare of vegetation as it is in midwinter, before they take their departure. This is not overstating the case, and the farmers of the threatened region should count on such a probability and do all in their power to avoid it.

The insects have already hatched out largely toward the Gulf, and the bulk of them will hatch in lat. 35° about the middle of the month. They will continue to hatch most numerously about four days later with each degree of latitude north, until along the 49th parallel the same scenes will be repeated that occurred in Southern Texas seven or eight weeks before. In the S. W. counties of Missouri hatching will be at its height about the second week in April; in the N. W. counties a few days later. Wherever they hatch in quantities, the injury will at first be confined to particular fields and locations; but as they increase in size they will become more and more injurious and widen the area of their devastations until, if nothing be done to prevent it, they will ruin most crops by the time the bulk of them acquire wings—leaving, in extreme cases, no plant untouched but the little *Amarantus Blitum*. This will occur in from six to eight weeks after hatching, and the winged swarms in South Texas will be leaving that country early in May or about the time the young are beginning to hatch near the British American line.

The unfledged locusts will travel in no especial direction, but in different directions, and they will not extend, on an average, more than ten miles east of any point where they hatched out. The winged insects, on the contrary, will take their departure in a northerly or northwesterly direction—at least, this will be the prevailing direction of those which rise during the months of May and June. The course of those which rise later may not be so constant. Those that escape from the many vicissitudes that will befall them in the Mississippi Valley, and which are free from disease or parasites when they start, will, in all probability, eventually reach the extreme Northwest, and be largely lost to view beyond our northern boundary. They will not fly eastward so as to do any serious damage beyond the line indicated in the map.

Such are the probabilities for the Spring and Summer. They are not particularly encouraging!

I will now state a few of the modifying circumstances and of the possibilities that will lighten the darkness of the picture and may very materially diminish the prospective damage.

Firstly—The farmers are in much better condition to withstand the temporary loss than they were in the Spring of 1874.

Secondly—They are far more thoroughly posted as to the prospects and better organized to fight the enemy. Correct information has been very widely circulated through the media of special reports and of the agricultural press. The bounty laws enacted during the winter will incite to action and will have a beneficial effect. The people are anticipating and preparing where two years ago they were comparatively indifferent. They are profiting by the experience of 1874–5. This is more particularly the case in Kansas, Nebraska, Iowa and Minnesota, and I regret to say less so in Missouri; for in some of our counties which are threatened, there is no organization and little preparation to meet the enemy.

Thirdly—I could not help noticing, and the same thing was remarked by many others, that quite a number of the insects observed last Fall, were much beneath the average size and generally darker than the typical specimens. Also a certain proportion of the eggs that I have received during the Winter, were far below the average size and much more predisposed to rot than the rest. I am strongly of the opinion that such specimens belonged to the swarms which developed in Minnesota and thereabouts, and which, after being repulsed in their efforts to get N. W., joined and formed part of the larger swarms which came from the farther N. W. The insects that hatched in Minnesota were in many instances the 3d and 4th generation bred there, and their degeneracy was very generally observed. Thus, expressions to the effect that the locusts there last Summer, were "used up," "tired out," etc., were common among farmers, and Mr. Whitman notes (Special Report for 1876, p. 12) the gradual decrease in the extent of the breeding grounds from year to year. More eggs have also rotted and the parasites have been more numerous there than elsewhere; while the injury has not compared to what it was in our State in 1875. The greater longevity of many of the insects of 1876 as compared with those of 1874, would also indicate that they were bred south of the region where the species is permanent and comes to greatest perfection. We may therefore expect that, as compared with 1875, a larger proportion of the young that will hatch in 1877, will be weakly and soon perish; for I know from my breeding experiments that there is great difference in constitutional vigor between them.

Fourthly—There is a bare possibility that, after the bulk of the young have hatched, and before they have commenced to do serious harm, we may have such unseasonably cold and wet weather as to kill them by myriads, and effectually weaken their power for injury.

Fifthly—Let the destruction be as complete as it well can, and there is every assurance that the insects will vacate the country in which they were born, soon enough to permit the planting and harvesting of a great many of the more important vegetables, and with a favorable Fall, a good crop of corn. This is more particularly true of Missouri, and the country S. of the 44th parallel and E. of the 100th meridian, which country I have designated as outside the species' habitat. It is less true of the country W. and N. of those lines.

As to the prospects later in the year, it is impossible to predicate with the same degree of assurance. There were no locusts to do harm in Manitoba in 1876, and it would seem that the Saskatchawan country must have been more or less depleted by the swarms which overspread our country. I am inclined to hope and believe that there will not be another general invasion next autumn, and that the people of Texas, Indian Territory, Arkansas, Missouri, Kansas, Nebraska, Iowa, South Dakota and even Minnesota, may expect immunity for a few years to come; after the hosts which are about to hatch are destroyed or wing themselves away. There may be partial injury from their progeny in 1878, or even 1879, in parts of the country named, especially toward the N. W.; but there will be no general destruction. In Missouri we may confidently hope for immunity for from seven to ten years.

In conclusion, I would urge our farmers in the threatened country to prepare to carry out the recommendations given in this Report; to provide themselves with northern grown, early-ripening, seed-corn; to sell no hogs nor poultry; and to diversify their crops by growing more tuberous and leguminous plants.

In the language of the Omaha Conference report: "Above all, do not get discouraged! Come what may, do not ask for outside aid! We do not believe there ever will be any need of it: it is, in the end, demoralizing. * * * * *

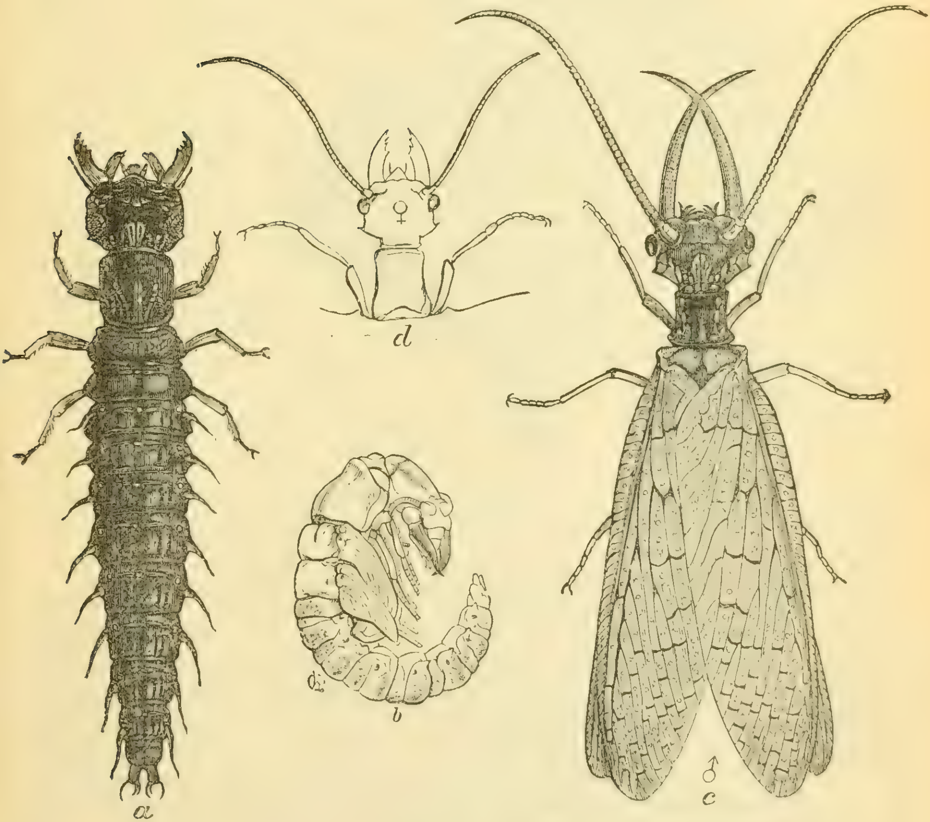
"There is no part of the country that is not subject to meteorological or entomological excesses, and in the long run the locust is not more injurious than are some insects in other parts of the country. When we think of the famine and utter destitution that at times overtake some of the Eastern peoples, we may well thank the Almighty that we live in a land of such resources and promise. The threatened country has prospered in the past: it will prosper in the future; and in proportion as we meet this locust enemy with enterprise and concerted, intelligent action, in that proportion shall we vanquish it."

INNOXIOUS INSECTS.

THE HELLGRAMMITE.—*Corydalus cornutus* (Linn).

[Ord. NEUROPTERA ; Fam. SIALIDÆ.]

[Fig. 30.]

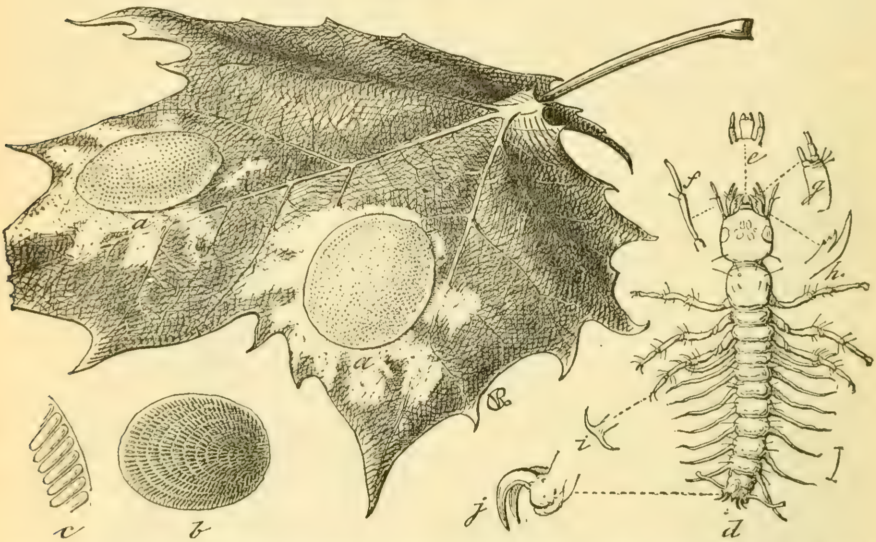


THE HELLGRAMMITE:—*a*, larva; *b*, pupa; *c*, male fly; *d*, head and jaws of female.

The following paper "On the curious Egg-mass of Corydalus cornutus (Linn.) and on the Eggs that have hitherto been referred to that Species," read by me at the last meeting of the American Association for the Advancement of Science, will correct and supplement the article on the same insect published in my 5th Report:

Our largest Neuropteron, belonging to the family Sialidæ, is *Corydalus cornutus*. It is not uncommon in the Eastern and Middle States, and is known in the Mississippi Valley by the vulgar name of Hellgrammite. In the female the mandibles are quite formidable, but in the male they are curiously modified, and form long, incurved, smooth, prehensile organs of the form of the finger of a grain-cradle, and evidently of use in enabling him to embrace his mate. The larva of this fly occurs in running streams, living mostly at the bottom, and hiding under stones in the swiftest parts. It has strong jaws, and in addition to the ordinary stigmata, it is furnished with two sets of gills, one set lateral and filamentous, the other ventral, and each composed of a sponge-like mass of short rust-brown fibres.

[Fig. 31.]



CORYDALUS CORNUTUS:—*a*, *a*, egg-masses attached; *b*, one detached, showing lower surface—all rather below average size; *c*, a few eggs of the outer row; *d*, the newly-hatched larva; *e*, labium; *f*, antenna; *g*, maxilla; *h*, mandible; *i*, tarsal claw; *j*, anal hooks—all enlarged.

Its body terminates in two fleshy tubercles, each armed with a pair of hooks. It is best known in the full grown condition when, in seeking for a place in which to undergo its transformations, it travels and climbs on the shores of our rivers, and sometimes to long distances. Called a "crawler" by fishermen, it is greatly esteemed as bait. The pupa is quiescent and formed in a cavity in the ground. The supposed eggs of this insect were figured and described in the *American Entomologist*, and in the Fifth Missouri Entomological Report, as oval, about the size of a radish seed, and deposited in closely set patches of fifty and upward upon reeds and other aquatic plants; and they have since been frequently referred to, no one questioning the accuracy of the conclusion of their discoverer, the late B. D. Walsh.

About the middle of last July, in sailing up the Mississippi river between Bushberg and St. Louis, my attention was attracted by sundry white splashes on the leaves of various plants that overhung the water; which splashes looked, at a distance, not unlike the droppings of some large bird. Approaching more closely to them, however, they were seen to consist of sub-oval or circular swellings, with more or less white splashed around them ; and upon still closer examination, they proved to be egg-masses. They were generally attached one to the upper surface of a leaf either of Sycamore, Elm, Cottonwood or Grapevine ; but sometimes there were several on the same leaf, and at others they occurred on both sides of the leaf. It was evident that the leaves were objects of attachment only, * and from the fact that only those which overhung the water were selected by the parent, it was natural to infer that the species was aquatic in its larva state. Yet the egg-masses greatly puzzled me, as indeeed they did all naturalists to whom I referred them ; for the eggs of the larger water-beetles were known, those of *Corydalus* were supposed to be known, and there was only one other water insect in North America, viz : *Belostoma grandis*, large enough to be capable of laying such a mass. But these eggs were evidently not Heteropterous.

Patiently waiting till the eggs hatched, I recognised at once, in the young larva, the characters of *Corydalus cornutus*, with the full grown larva of which I was familiar ; and upon dissecting the abdomen of a female Hellgrammite, the nature of the curious egg-masses was fully confirmed in the perfect identity in shape and arrangement of the eggs composing them, and of those in said abdomen.

The egg-mass of *Corydalus cornutus* is either broadly oval, circular, or (more exceptionally) even pyriform in circumference, flat on the attached side, and plano-convex on the exposed side. It averages 21 mm. in length, and is covered with a white or cream-colored albuminous secretion, which is generally splashed around the mass on the leaf or other object of attachment. It contains from two to three thousand eggs, each of which is 1.3 mm. long, and about one-third as wide, ellipsoidal,translucent, sordid white, with a delicate shell, and surrounded and separated from the adjoining eggs by a thin layer of the same white albuminous material which covers the whole. The outer layer forms a compact arch, with the anterior ends pointing inwards, and the posterior ends showing like faint dots through the white covering. Those of the marginal row lie flat on the attached surface ; the others gradually diverge outwardly so that the central ones are at right angles with said object. Beneath this vaulted layer the rest lie on a plane with the leaf, those touching it in concentric rows ; the rest packed in irregularly. Before hatching, the dark eyes of the embryon show distinctly through the delicate shell, and the eggs assume a darker color, which contrasts more strongly with the white intervening matter.

The young crawl from under the mass, and leave the vaulted covering intact. They all hatch simultaneously, and in the night.

The egg-burster† has the form of the common immature mushroom, and is easily perceived on the end of the vacated shell. The young larvæ crawl readily upon dry surfaces, with their tails hoisted in the air, and live for a day or more out of water ; but when hatching out over an aquarium, they instinctively drop to the water, where, after resting for a while, with their bodies hanging down and their heads bent forward at the surface, they swim to the bottom by whipping the body from side to side very much as a mosquito wriggler does. Here they secrete themselves and remain until, in the course of a few days they perish. They cannot be reared in confinement, and running water is doubtless as essential to them as to the full grown larva.

The newly hatched larva is almost colorless and differs from the full-grown larva, in the relatively longer legs and lateral filaments ; in these last being smooth and not

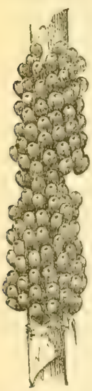
* Since this was written, I learn from Mr. Lintner, of Albany, N. Y., that he has found these egg-masses attached to rocks in the Mohawk river, though he had no knowledge of their parentage.

† I am not aware that this special structure has been named. It is generally, if not always, a part of the ambion, and is common to many insects, though varying much in form. It may be known as the *ruptor ovi*. Dr. Hagen has called it the "egg-burster," while erpetologists designate as the "egg-tooth," a structure having the same purpose.

clothed with short hairs ; in the abdomen not bulging at the middle, and in lacking the sponge-like gills beneath. The head is wider than the rest of the body, which tapers from the first to the last joints. The prothoracic is as long as, or longer, than the meso-and metathoracic joints together, and the abdominal joints increase in length as they diminish in width. The legs are nearly thrice as long as the width of the thoracic joints; the claws are movable and about $\frac{1}{3}$ as long as the tarsus; the tibia and tarsus are sub-equal ; the femur somewhat longer ; the coxa and trochanter about as long as the femur; there is a whorl of bristles toward the end of the femur and of the tibia. The mandibles are stout, with two principle teeth, the basal with 3 notches and the terminal one finely serrate : the maxillæ are elongate, reaching beyond the jaws, and with a simple inner and a 2-jointed outer palpus, both having basal folds, which often look like a basal joint : the antennæ are 3-jointed, and reach beyond the jaws, the middle joint longest, the terminal one nearly as long, and tapering : the labium is elongate-quadrate, tipped with two small tubercles, and with the palpi 2-jointed—the joints sub-equal. A few hairs occur on the sides of the abdomen between the filaments.

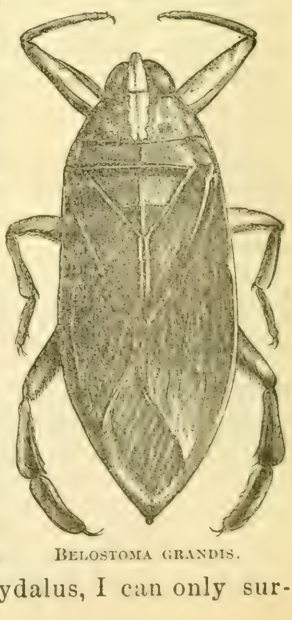
The fact that the young larva lacks the spongy masses of short fibres which characterize the mature larva, and which have been looked upon as accessory gills, would indicate that their purpose is rather to assist the creature, when it gets large, in adhering to the surface of stones at the bottom of swift-flowing waters. Though the larva can live for some time out of water, even when young; yet, until it attains its growth it is strictly aquatic, abounding most in rapid flowing streams, and especially such as have a rocky bottom, upon which it crawls slowly about, feeding upon other aquatic insects, especially Ephemerid larvæ, some of which, taken from the stomach, I have been able to recognize as belonging to the genus *Palingenia*.

[Fig. 32.]



Probable Eggs of Belostoma.

[Fig. 33.]



Belostoma grandis.

Mr. J. H. Comstock of Cornell University, who has for several years studied the habits of this larva around Ithaca N. Y., generally finds it in the most rapid portions of streams, where it dwells mostly under stones. He has captured numbers by turning over large stones and allowing the current to wash the larvæ into a dip-net; and he is of the opinion, which my own observations support, that the species lives three years in this larval condition.

By carefully studying the anatomy of the species, he has also discovered an additional pair of rudimentary spiracles on the hind part of a prominent fold between the meso- and metathoracic joints.

As to the nature of the eggs (Fig. 32) that have hitherto been mistaken for those of Corydalus, I can only surmise. The specimens from which the figure was made were destroyed with the Walsh cabinet in the Chicago fire; but I have a very distinct recollection of them, and judging from the nature of the eggs of *Perthostoma*, with which I am familiar, there is little doubt in my mind that these supposed eggs of Corydalus really belong to *Belostoma grandis*, (Fig. 33) which is the only aquatic Heteropterous insect of sufficient size to lay them.

THE YUCCA BORER—*Megathymus yuccæ* (Walker.)

[Ord. LEPIDOPTERA; Fam. HESPERIDÆ]

Having, during the year, reared this interesting butterfly from the egg, so as to watch its growth, I can supplement the article published a year ago by stating, positively, that there is but one generation annually, and that the characteristic glistening powder that covers the full grown larva, is not secreted till toward the last molt. The larva referred to on p. 181 of my Eighth Report, as being kept in a tin box, and fed solely on the leaves, lived till the 25th of September. It formed a perfect cylinder of silk and excrement around the bottom of the box, fastening thereto the ends of the cut leaves, so that the cylinder was necessarily broken each time the leaves were changed. This specimen went through no less than seven molts at irregular intervals of 10, 11, 24, 14, 61, 15 and 21 days respectively. It changed but little in appearance, except in becoming somewhat paler, after the second molt, and died when about three-fourths grown—death resulting, I think, more from the mould that formed from the excrement, and which it was impossible to prevent, than from the nature of its food. It is doubtful if so many molts are suffered in more natural and healthy conditions.

Another specimen that entered a Yucca plant in the garden of my friend, Dr. G. Engelmann, throve admirably, extending over a foot beneath the ground, and attaining full growth by the end of September; while a third, in a potted *Yucca aloifolia* in-doors, hollowed out the entire root, pupated on the 26th of January, 1877, and gave out the imago on the 25th of the following month.

INDEX.

F

G

H

I

K

L

M

N

O

P

R

ERRATA.

Page 6, line 26 insert after "moth" (*Euphanessa mendica*, Walk.)
Page 15, line 3 for "entite" read "entire."
Page 50, explanation of cut, for "*e*" read "*c*."
Page 50, line 3 from bottom, for "Hubner" read "Huebner."
Page 54, last line, in place of the comma, write "is."
Page 55, line 1, for "the other" read "the second."
Page 55, line 9 from bottom for "m. m" read "mm."
Page 55, line 7 from bottom, strike out the "on."
Page 56, line 1, for "m. m" read "mm."
Page 56, line 2, for the last "and" read "anal."
Page 56, line 32, commence a new ¶ with "Chrysalis" and italicize it.
Page 57, for "*Spretus*" in the heading read "*spretus*."
Page 58, line 14, strike out "have."
Page 89, line 13, strike out the "i" after "embryon."
Page 98, line 11 from bottom, for "*Compoplex*" read "*Campoplex*."