ON PHYTOPHAGIC VARIETIES AND PHYTOPHAGIC SPECIES.

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It is well known, especially to breeders of Lepidoptera, that there are certain species of Insects, which in the larva state feed only on one particular species or a few closely allied species of plants, and others which feed on a great variety of plants belonging to different species and genera, and even to different and widely distinct families. For example, *Attacus Luna* Drury occurs only on the walnut and hickory, while *Attacus Cecropia* Lin. is found, according to Harris, on apple, cherry and plum trees, and on currant and barberry bushes, and I have reason to believe that it feeds also on the common hazel. But there is a still more remarkable example of diversified tastes in *Dryocampa imperialis* Drury, which feeds sometimes on the sycamore, an angiospermous tree, and sometimes on the pine, a gymnospermous tree.

Occasionally this difference of food causes certain differences in the insect itself, either in the larva or in the imago state. Thus the larvæ of *Datana ministra* Drury that occur on the oak, the apple tree, the thorn and several other trees, almost invariably have a large yellow spot behind the head, and always have pale longitudinal lines on the body; while those that are found on the hickory are either entirely black, or are longitudinally lineate with whitish without any yellow spot behind the head. But as this last variety also occurs on the oak, and the imago bred from the black variety on the hickory is absolutely identical with the imago bred from the yellow-necked and striped variety on the oak, as I have experimentally ascertained, it would seem that the two forms cannot be distinct. Again, I have taken numerous specimens of *Chrysomela scalaris* Lec. on the elm and basswood, which measure in length .35—.40 inch; and on the dogwood (cornus) and wild plum I have for many years back taken whole swarms along with their larvæ, which ranged from .27 to .30 inch in length, and none of which exceeded the latter measurement. Yet on the closest inspection I could discover no other distinctive character but size, and on forwarding specimens of both forms three years ago to Dr. LeConte with a statement of the facts, they were pronounced by him to be iden-

tical. It is observable that Rogers gives the length of this species as .32—.40 inch, (*Proc. Ac. Nat. Sc. Phil.*, Feb. 1856, p. 32) and Harris as "about .30 inch," the accompanying figure being .40 inch long. (*Inj. Ins.* p. 132.)* Thirdly, *Haltica alternata* Illig. (= 5-*vittata* Say according to LeConte MS.) is stated by Say to be "found in considerable numbers on the common elder (Sambucus) and some other plants," and is described by him as having five vittæ on the elytra. Although he notices two variations in the coloration of the head and thorax, he says not a word as to the elytral vittæ ever being subobsolete or obsolete. (*Say's Works*, II. p. 227.) I have three specimens in my Cabinet, captured some years ago, but on what plant I have no record, all of which have the elytral vittæ deep black, and very nearly as wide as the yellowish interspaces. As the elder grows abundantly near Rock Island, they may very probably have fed in the larva state upon that plant. In the first few days of August, 1864, I captured on the gall *Salicis brassicoides* Walsh, which is peculiar to Salix longifolia, a subaquatic willow, six specimens with the elytral vittæ distinct and black but ⅓ narrower than in my Cabinet specimens, and one with the elytral vittæ pale and almost obsolete; and on August 6th, I bred a specimen from that gall with the elytral vittæ pale and almost obsolete. On August 9th I captured, mostly on the wing, in a patch of Salix humilis —a dwarf upland willow, which bears a gall, *Salicis rhodoides* Walsh, constructed on the same principle as *S. brassicoides*—twenty specimens of this species, one with the vittæ distinct and black but ½ narrower than in my cabinet specimens, seven with the vittæ pale and more or less indistinct, and twelve with the vittæ more or less entirely obsolete. I have also received from Chicago two specimens with the vittæ entirely

* I have noticed that *C. Bigsbyana* Kby. occurs *along with its larva* exclusively on willows, and *C. casta* Rogers, on a weed, the name of which I do not know. *Casta* is an Illinois and Kansas species, and is supposed by Dr. LeConte (MS.) to be a mere variety of *pulcra* Fabr.: but *pulcra*, which is a much larger species, does not occur near Rock Island, while *casta* is very abundant there. It would be interesting to know on what plant *pulcra* feeds, and also on what plant *Chr. Philadelphica* feeds, which so closely resembles *Bigsbyana*. Of *Philadelphica* I have taken but a single specimen near Rock Island in seven years, while *Bigsbyana* is very abundant there. It will be a great help towards separating the species of this difficult genus to note the plant or plants on which they are found *in company with their larvæ*, i. e. on which they feed.

obsolete, but on what plant they occurred I do not know. From these facts I infer that *H. alternata*, when it inhabits the elder, has the elytral vittæ distinct and black, and that, when it inhabits the willow, there is a strong tendency for those vittæ to become obsolete, less strong perhaps when it feeds on Salix longifolia, and more strong when it feeds on S. humilis. Finally, I know from my own boyish experience, that when the common silk worm is fed entirely upon lettuce leaves from the egg to its adult stage, it always spins not yellow, but whitish silk; but whether this variation in the color of its secretions is correlated with any variation in the larva or imago state of the insect, I cannot say. Many other such examples will occur to every intelligent and observing field-entomologist. Varieties of the above character, i. e. where certain unimportant characters in the insect are correlated with the food-plant, while at the same time there is no sufficient reason to doubt that the two varieties freely intercross, I propose, for convenience' sake, to call Phytophagic Varieties. We may observe that Phytophagic Varieties, like Dimorphous and Trimorphous forms, (*Proc. Ent. Soc. Phil.* pp. 221—3) sometimes—at all events if the dwarfed form of *Chr. scalaris* be considered merely as a variety—offer an exception to the general law, that the absence of intermediate forms proves diversity of species.

Even with the little we know of the Laws of Inheritance, we might infer *a priori*, that when from peculiar circumstances a Phytophagic Variety, including both the sexes, has fed for a great many generations upon one particular plant of the number inhabited by the species to which it belongs, it would be likely to transmit to its descendants in the imago state a tendency to select that particular plant upon which to deposit its eggs. We know, for example, that young pointer puppies, when taken into the field, will frequently point game without any instruction or training whatever, though the habit of pointing is clearly an acquired and not a natural habit, and must have been transmitted to them from their ancestors in virtue of the Laws of Inheritance. If, then, it should so happen, that, owing to the presence of but a single species of the plants ordinarily fed upon by a particular species of insects, or to other causes, eggs have been uniformly deposited by a Phytophagic Variety upon the same plant for an indefinitely long series of generations—say fifty, or a hundred, or a thousand, or ten thousand—

and the female has in no case intercrossed with a male belonging to a different Phytophagic Variety, then it is probable that habit will have become a second nature, and that it will cease to be possible for that insect, which by the supposition has fed upon that one plant for a very long series of years, to feed upon any other plant than that to which it has become habituated by the Laws of Inheritance.

But before this point is reached, another series of phenomena will have come into play. Every naturalist is aware that species often run into what are known as geographical races, when separated into two or more distinct groups by physical barriers. Just so the Phytophagic Variety, having by the supposition been isolated from the other members of its species, will often run into what may be called Phytophagic Races, and finally perhaps acquire either a moral indisposition, or a physical inability, to intercross with the other members of the species. It will then have become what I propose to call a Phytophagic Species, distinguished from the other members of the species to which it originally belonged by certain slight peculiarities of size, or of coloration, or occasionally even of structure, just as geographical races are so distinguished. But there will be this essential difference between the two cases: Geographical Races are connected, or supposed to be connected, by all the intermediate grades, and may therefore be reasonably concluded to intercross on the confines of their geographical boundaries. Phytophagic Species are not so connected, and by the supposition they do not intercross, or, at all events, only in very rare instances, as is sometimes the case with what are allowed on all hands to be distinct species.*

According to my views, Phytophagic Species are as truly distinct species as those which differ by much stronger characters. "The only valid practical criterion," as I have already said, (*Proc. Ent. Soc. Phil.* II. p. 220,) "of specific distinctness is the general non-existence, either actually ascertained or analogically inferred, of intermediate grades in the distinctive characters, whence we may reasonably conclude that the two supposed species are distinct, i. e. that they do not now in general

* Mr. Henry Shimer, of Carroll County, Illinois, writes me word that he has recently seen ♂ *Hippodamia maculata* DeGeer copulating with ♀ *Coccinella novemnotata* Hbst. He has sent me specimens of both species, and I have no doubt that they were rightly determined by him. Similar examples in this family have already been referred to by me. (*Proc. Ent. Soc. Phil.* I. p. 351.)

mix sexually together, or if geographically separated, that they would not do so, supposing them to be placed in juxtaposition." According to this view of what Darwin calls "the undiscovered and undiscoverable essence of the term species," (*Orig. Spec.* p. 421,) it is immaterial whether the distinctive characters be slight or strong, so that they be perfectly constant. But as many naturalists are of opinion, that to constitute a distinct species it is necessary that the distinctive characters should be tolerably strong, it will be better to distinguish Phytophagic Species by this particular denomination, and not confound them with the general mass of what are known as distinct species. After all, the difference of views on this subject is a difference only in words and not in things. I consider as species all forms which do not habitually intermix in a state of nature—as according to the definition of the term Phytophagic Species do not—the absence of intermediate grades being, as a general rule, taken as the criterion of the species not habitually intermixing in a state of nature. Others require in addition, that the distinctive characters should be of a certain type, which is left to be fixed and defined in each particular genus by certain varying and somewhat indefinite rules. It is evident, therefore, that the term "species" is used here in two different senses, and to avoid ambiguity it is necessary to distinguish the doubtful and disputed forms by some particular name.

It may be asked why the process by which Phytophagic Species are formed is not reiterated on all hands, till Nature becomes a Babel of confusion and the number of distinct species equals the grains of sand on the sea-shore. The answer is simple. There are two great antagonistic forces in Nature, the Law of Variation, causing individuals of almost all species to assume occasionally abnormal characters or abnormal propensities, and what may be called THE LAW OF ASSIMILATION, which, by the intercrossing of these abnormal individuals and their descendants with the normal type, gradually in successive generations softens down, eliminates and extirpates whatever is strange and peculiar in them. Thus, American families of the pure Caucasian race, which intercrossed in a single instance many generations since with the Red Indian, have already, by successive intercrosses with the White Race, completely eliminated all traces of Indian blood. It can only be in very rare cases indeed, that the process which I have been describing can be carried

to its full completion, because it can only be in very rare cases indeed, that intercrossing with the other Phytophagic Varieties of the same species can be avoided, and the Law of Assimilation prevented from coming into play.

If these views be correct, we might expect to find Phytophagic Varieties and Phytophagic Species most abundant in those vegetable-feeding genera, where the imago flies but little, or flies very weakly, or has no wings at all, and where consequently intercrossing does not so readily take place. Such genera are *Cynips* and its allies in Hymenoptera, *Cecidomyia* in Diptera, *Aphis* and its allies and *Coccus* and its allies in Homoptera, *Tingis* in Heteroptera, and *Diapheromera* in Orthoptera, though this last makes up perhaps to a certain extent for its want of wings by its great powers of walking. All authors have remarked upon the minute shades of difference that distinguish the species of the four first genera and their allies, and upon their being frequently restricted to certain species of plants. I have myself recently observed, that an apparently undescribed species of *Tingis*, which occurs profusely on the basswood and the false indigo (amorpha fruticosa), when it occurs on the latter plant is always distinguished from the bass-inhabiting type by the carinate basal cell of the elytra terminating behind nearly in a rectangle, instead of an angle of about 60° or 80°, and is probably, therefore, divisable into two Phytophagic species.*

* I have before referred to this *Tingis*, (*Proc. Ent. Soc. Phil.* I. p. 295.) though I had not then noticed the nice structural distinction between the two forms inhabiting respectively the bass and false indigo. Some specimens found on the wild cherry were identical with the bass-inhabiting form, and as they occurred on a tree not far removed from several basswoods, might possibly have flown there from them. The false indigos on which the other form occurred had no trees growing within a furlong of them. Believing the two forms to be distinct Phytophagic Species, and that both are undescribed, I annex descriptions:

Tingis tiliæ n. sp. Pale brownish yellow. *Head* more or less blackish. Eyes black. Antennæ nearly as long as the body, finely pilose when held up to the light, the terminal joint thickened and blackish, joints 1 and 4 each twice as long as joint 2, and joint 3 about four times as long as joint 4. *Prothorax* laterally dilated in a thin, semitransparent plate directed upwards and outwards, and filled with small suborbicular cells like those of the elytra. This plate commences from nothing at the origin of the elytra, and thence gradually widens to one-fifth the width of the entire prothorax at the lateral middle, where it curves inwards rather suddenly and is prolonged forwards in a very gentle con-

And lastly, I have in 1864 found a ♀ *Diapheromera* in a place overgrown by weeds beneath the boughs of two isolated ash-trees, which differs remarkably from some dozen ♀ *D. femorata* Say which I have examined, in the caudal appendages (cerci) being nearly four times as long, and the supraanal plate larger and more elongated, and also in the anterior femora being rather incrassated than laterally dilated into a thin plate, in their dilatation being considerably less and

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vex curve without varying in width, and extends over the head in the form of an elevated oblong, which projects forwards nearly in a rectangle with its apex obtuse, and is carinate longitudinally above. From the hind margin of this oblong extend backwards the three normal carinæ, the outer ones gently sinuate, but the general course of the three nearly parallel. The spaces between these carinæ, and outside them as far as the thin plate of the prothorax, are blackish and rugose as far back as the insertion of the elytra; the triangular space behind that insertion being covered with large, dilated confluent punctures, having much the appearance of the small suborbicular cells of the elytra. Beneath, except the lateral plates of the prothorax and the carinate edges of the central pieces of the sternum, blackish. *Elytra* hyaline on their terminal half, but with the cell-veins there pale yellowish brown and occasionally towards the tip of the wing a few of them irregularly blackish; the large carinate cell at their base extending nearly half way to the tip, and terminating in an angle of 60°—80°, from which there extends a simple sinuate carina nearly to the tip. A little on the basal side of the middle of the elytrum and extending half way to its base, the veins outside the large carinate cell are irregularly and variably blackened more or less, so as often to present the appearance of 1—3 transverse blackish lines; and occasionally the blackness extends across the entire elytrum, so as to appear like a blackish fascia. *Legs* with the tarsi, or sometime only their tips, blackish.—Length about .15 inch. Eleven specimens from basswood, three from wild cherry. Very abundant near Rock Island on the basswood.

Tingis amorphæ, n. sp. Differs from the above only in the large, basal, carinate cell of the elytra terminating behind nearly in a rectangle instead of an angle of 60°—80°, and in the veins of the wings, both those on the basal side of the middle and those at the tip, being on the average of specimens much more deeply stained with black, though individuals of the two species occur which are identical in this character.—Length about .15 inch. Eighteen specimens on Amorpha fruticosa.

I possess in this genus *T. mutica* Say, *plexus* Say, *oblonga* Say, *juglandis?* Fitch, and eight or nine other species, most of which are probably undescribed. Say gives the length of *T. arcuata* as nearly three-*tenths* of an inch, but this is probably a typographical error for three-*twentieths*. (Compare Fitch *N. Y. Rep.* II. ♀ 193.) Conversely in Say's Works (II. p. 131) the length of *Copris anaglypticus* is given as 7-20 instead of 7-10 inch.

not commencing quite so abruptly near their basal portion, and in the general color being grass-green instead of cinereous-brown. After I had recognized the above as a distinct species, I received from my ornithological friend, Dr. Velie of Rock Island, single specimens of both sexes, captured by himself in a place overgrown by weeds, but with no trees within a long distance of it, on the North bank of the Platte River, in Nebraska The ♀ agrees in every respect with mine; the ♂ differs from the ♂ of *femorata*, 1st, in the general color being much more green, 2nd in the anterior femora being rather less incrassated, 3rd in the middle femora not being trifasciate with brown, 4th in the supra-anal plate terminating in two acutely angular, horizontally flattened teeth, instead of being rounded at tip, 5th in the interior base of the caudal appendage being furnished with an acute thorn, directed backwards and nearly as long as the appendage is wide, instead of a large, vertically flattened, rounded lamina directed backwards. In all other respects both sexes agree with *femorata*, but the marked difference in the caudal appendages ♂ ♀ would alone be sufficient to separate them as distinct. I propose for this species the name of *Diapheromera Velii*. Although there is no positive proof that it is a Phytophagic Species, yet as *femorata* ordinarily occurs upon forest trees, (oak, basswood, &c.,) and never, so far as I have observed—and I have probably had a thousand specimens pass through my hands—in localities where there are no trees, I incline to believe that it is.

It is not necessary, however, that in every case Phytophagic Species should take their origin from Phytophagic Varieties, using the term "variety" in the sense ordinarily given to it by entomological Systematists. It sometimes happens that what is to all external appearance one homogeneous species is composed of two or more distinct races, feeding each upon a distinct plant, but not distinguishable, either in the imago or so far as known in the larva state, by any external characters whatever, whether colorational or structural. We meet apparently with a case of this kind in *Cynips q. spongifica* O. S. and *C. q. inanis* O. S., the former of which forms a gall on the Black Oak and the latter a very different gall on the Red Oak, the imagos ♂ ♀, with the exception of the dimorphous ♀ form of the latter which is unknown, being to all appearance identical. I inclined to the opinion at one time that these two forms were identical, the difference in the

species of oak causing the difference in the nature of the galls, and the poisonous matter producing the gall being the same in both forms. But there are so many *Cynips* that produce exactly the same kind of gall on different species of oak, that it would seem that these two forms must be true Phytophagic Species, each generating a peculiar kind of gall-producing poison, and each with such internal differences as to cause them to generate secretions with such very different properties.

That there may be no possible mistake, it may be as well to say here, that the difference between what I call a Phytophagic Variety and what I call a Phytophagic Species is simply this:—The former habitually intercross with the normal race, the latter do not. Of course there must often be cases, where the fact of their habitually intercrossing or not so intercrossing is doubtful or cannot be satisfactorily inferred or ascertained, and allowing that the former category sometimes gradually in a long period of time merges into the latter, there must be occasionally intermediate categories. Still this is no reason why we should doubt or deny the existence of the categories themselves. Boyhood is one thing, and manhood is another thing; but there are intermediate periods when it is difficult to say whether the individual in question is boy or man. Yet it would be strange logic to argue that, on that account, boyhood was the same thing as manhood.

It must be obvious to every one, that it is impossible to trace the gradual formation of what I have called a Phytophagic Species *in time*, because by the supposition it requires very long periods of time for its development, and Natural History as a science is only a hundred years old. But if we are able to discover the several steps in the above-described process, not indeed in one and the same species, but in different species, and can thus trace an uninterrupted series from the first origin of the Phytophagic Variety to the full development of the Phytophagic Species, to all minds unbiassed by preconceived theories the proof will be complete. In any case, assuming the truth of the above Theory, this is the only possible way, in which for ages to come that truth can be demonstrated. For any one therefore to refuse to admit the validity of such proof, is equivalent to saying, that, even if the Theory is true, he will not believe it on the best possible evidence.

Investigations of this character require laborious and tedious experiments in the closet, and habits of patient observation and industry in

the field. The systematist who in his closet receives specimens from the four quarters of the globe, and busies himself in arranging and classifying them, can discover nothing here, or if he does he must be dependent entirely upon the accuracy of out-door observers. My present object, however, is not so much to adduce new proofs upon this subject, as, in the light of my subsequent experience, to correct, modify and enlarge upon those proofs which I have already adduced in a Paper published in the Proceedings of the Boston Society of Natural History, Feb. 1864. In the following paragraphs I shall refer to that paper by the page.

HALESIDOTA (lophocampa) ANTIPHOLA Walsh. (pp. 288—290.) I have shown here that the imago of *H. tessellaris* Sm. Abb., the larva of which feeds only on the sycamore, is absolutely undistinguishable from that of *H. Antiphola*, the larva of which feeds on the oak, the basswood and several other trees. But from trusting to a description drawn up some years ago, which I found in my Journal, one of the characters which distinguish the two larvæ is incorrectly stated. The black pencils on the thorax of the larva of *Antiphola* are in reality placed upon the same segments as the orange-colored pencils of *tessellaris*, viz. on the 2nd and 3rd, and not on the 1st and 2nd segments, as I have erroneously asserted; but they are invariably black, and those of *tessellaris* invariably orange-colored. The general color of the hair of *Antiphola* varies, as I have stated, "from dirty whitish to fuscous cinereous, and from ochre-yellowish to pale yellowish brown," all these varieties occurring on the same tree, the oak, and the same individual often changing its color in confinement. But I have this year met with a single specimen that was almost pure white, and two others that were straw-colored or pale gamboge-yellow; and the one that was nearly white changed its color in confinement in a single day to pale gamboge-yellowish. On the other hand the general color of the hair of all *tessellaris* that I have seen, some hundreds in number, was milk-white, though Dr. Harris describes them as "light-yellow or straw-colored." (*Inj. Ins.* p. 363.) Mr. Edwards also, to whose experience I had appealed on this point, says that "he knows the larva of *H. tessellaris* very well, and that to the best of his recollection they are white, though he would not like to assert positively that they had not a yellowish tinge." And Mr. J. A. Lintner writes me word that "he has frequently noticed

white tussock-larvæ on the trunks of the buttonwood [sycamore], which he presumes must be those of *H. tessellaris*, though he has not identified them with that species." In mature or nearly mature *Antiphola* the head is black; in half-grown or quarter-grown individuals, especially the latter, generally but not always pale rufous. In *tessellaris* of all ages the head is as described by Harris "brownish yellow" or pale rufous. (*Ibid.*)

I strongly incline to believe that *Antiphola* is the species known to Dr. Harris only in the larva state, and stated by him to occur "on the black walnut, the butternut, the ash and even on the oak," (*ibid.* p. 362,) although that species is not described by him as having any pencils on the 3rd segment, as *Antiphola* has. In all other respects the description agrees exactly. The pencils in the larvæ of this genus are so fragile, that the least touch knocks them off, and the specimen or specimens examined by Dr. Harris might have been so mutilated. There seems some peculiar proclivity to error in the matter of these pencils; for besides my own blunder referred to above, in the recent illustrated edition of Dr. Harris's *Injurious Insects* the larva of *H. caryæ* is figured with black pencils both on the 10th and 11th segments, whereas according to Dr. Harris's own description it has none on the 11th segment. (Compare *Inj. Ins.* Plate vi. fig. 1 and p. 361.) Whether the draughtsman or the engraver is here in error, or whether Dr. Harris himself is in error, I cannot say, as the species, though it occurs near Rock Island very rarely in the imago, is totally unknown to me in the larva state; but there is evidently error somewhere. I subjoin an amended and enlarged description of the larva of *Antiphola*.

H. Antiphola Walsh, (larva.) *Head* black, polished, the mouth varied with white. *Body* opaque black above, pale on the venter, covered above with dense hairs proceeding from little warts in evenly-shorn brushes or tufts, which are dorsally a little darker, and vary in color in different specimens from dirty whitish or occasionally almost pure white to fuscous cinereous, and from pale gamboge-yellowish to ochre-yellowish and pale yellowish brown, the brushes on the back converging so as to form a dense dorsal ridge. On the 2nd segment behind the head one lateral black pencil and two milk-white ones under it, all transversely arranged, the black pencils generally in repose directed horizontally forwards. On the 3rd segment one lateral black pencil and one milk-white one under it, directed obliquely forwards. On the 11th segment one lateral black pencil directed obliquely backwards, and on the 12th segment one less obvious pencil, which is either whitish or the color of the tufts of the body,

placed immediately behind the black pencil on the 11th segment, and often with a few long black hairs above it. Besides the pencils, there are also some long, irregular, whitish hairs projecting forwards over the head and backwards over the anus. *Legs* and *prolegs* very pale ferruginous, slightly obfuscated at tip.—When much less than half-grown, the head is generally not black but rufous, the black pencil on the 2nd segment is often only slightly tinged with black, and the pencils on the 11th and 12th segments are occasionally subobsolete or all whitish and untinged with black Food-plants, oak, basswood, elm, &c ; very common near Rock Island, Illinois.

I am not perfectly sure that the larva of *tessellaris* has white pencils under its orange-colored ones, as *Antiphola* has under its black ones; but unless my recollection of last year's specimens deceives me, it has. Harris however makes no mention of any such white pencils, and the only specimens I was able to procure in 1864 had their pencils so mutilated, that it was difficult to decide the question from them with absolute certainty. In Illinoian specimens of *tessellaris* it will be recollected, that the color of the tufts that cover the body above is white, and not dark as in almost all *Antiphola ;* and consequently in mutilated specimens it is difficult to distinguish the white pencils from the white tufts. It may be incidentally remarked here, that in Illinois *tessellaris* appears and disappears several weeks before *Antiphola*.

It will thus be seen that, so far as known at present, the only *perfectly* constant character that distinguishes the larva of *tessellaris* from that of *Antiphola*, is the color of its pencils being orange instead of black, and its food-plant being sycamore instead of oak, basswood, &c. Out of hundreds of *Antiphola* that have passed through my hands, there was indeed a single specimen, apparently freshly-moulted, as the pencils were incurved at the tip instead of being straight, that had those pencils white which ought to have been black; but on placing it in a breeding-cage, I found that the next day they had changed to their normal color, although those on the 2nd and 11th segments were much paler than usual. This was the same specimen before referred to as having changed its general color in confinement from white to gamboge yellowish.

If the pencils themselves in these two forms had been located on different segments, as in the first instance I had wrongly supposed, there could have been no doubt of the specific distinctness of the two, the differences being structural; but as the two forms only differ in the

color of their pencils and not in their *location*, and the imagos are identical, it may well admit of a question whether they are not mere Phytophagic Varieties. It became desirable therefore to test this point in the manner recounted below, the principles of which it will be necessary first to explain.

When a species feeds indiscriminately upon several plants, individuals, that have fed for a certain period upon one of those plants, may be shifted upon another of the plants that they commonly feed on without injury to their health. I have done this in so many different cases with Lepidopterous larvæ, that I believe that, in their case at all events, it is a general law. For example, it is a common practice in England, and I have repeatedly done so when a boy, to feed the common silkworm when it first hatches out on lettuce leaves, and afterwards to change its food to mulberry leaves. Yet the insect thrives just as well, and spins up just as certainly under this treatment, as if it had been fed on mulberry leaves throughout. Lepidopterous larvæ will even sometimes voluntarily shift, from a plant of one family to another of a very widely distinct family. Several years ago I had, in the same cage, about a score half-grown larvæ of *Spilosoma virginica* Fab. feeding on apple leaves, and by the side of them several larvæ of *Pyrameis huntera* Sm. Abb. feeding on sunflower leaves. To my great surprise the former all suddenly quitted the apple-leaves for the sunflower-leaves, and I finished them on that plant and they, most of them, developed next year into the imago.

In confirmation of these views, Mr. Edwards, to whom I had referred for his opinion on this subject, writes to me as follows :—"I have often found that where I had one larva, say of *excæcata*, from the elm and another of the same from the cherry, and put food for both in the same vase, the two would be probably both of them on the cherry soon after. I have often changed the food-plant, when the one on which I found a larva was inconvenient to procure, for one nearer the house that I knew it liked. I have collected larvæ of *Limacodes* from oak, hickory, wild cherry and cherry, and have put the lot on a hickory or oak near my house. They did just as well."

On general principles, therefore, if *Antiphola* and *tessellaris* were mere Phytophagic Varieties, and not Phytophagic Species, it must be obvious that it would be possible to feed *tessellaris* on oak-leaves and *Antiphola*

on sycamore-leaves without injury to their health; and in that case we might expect that the pencils of the one would more or less partially assume the color peculiar to the pencils of the other. Owing to the very great scarcity of almost all species of insects in 1864, I was unable to procure a sufficient number of individuals to try such experiments on a large scale; but such as they are, the results of my experiments, as extracted from my Journal, are given below. Since it is possible that on the supposition of *tessellaris* being identical with *Antiphola*, or, in other words, that they are mere Phytophagic Varieties of one species, there might be some peculiarity in the constitution of that species, causing it to deviate from the general law, and suffer in its health or even die from change of food, I also tried the experiment of feeding upon oak-leaves *Antiphola* that had been found upon basswood, and feeding upon basswood-leaves *Antiphola* which had been found upon oak. The results given below show that it is possible to so shift them, though not perhaps with perfect impunity, and that a basswood-feeding *Antiphola* lived for at least 12 days upon oak-leaves, and an oak-feeding *Antiphola* grew and flourished for 22 days upon basswood leaves, and two days afterwards spun up. In all these cases, except where otherwise specified, the larvæ were well attended to and the leaves not suffered to wilt.

Breeding-cage No. 1. Food-plant *oak*. This was a large cage containing nearly two cubic feet of space, with 3 or 4 inches of earth at the bottom and the top and sides of wire-gauze, so that there was no possibility of any but very minute larvæ escaping. It contained already, on Sept. 6, several score of larvæ of many different species, but of course no *Halesidota*, and I added others subsequently.

Sept 6. Placed in it 4 *H. Antiphola* taken off basswood, all lively, one ¼-grown, two ½-grown and one ¾-grown.

Sept. 9. Shifted on to fresh leaves. Found two lively *Antiphola*; the other two had disappeared.

Sept 12. Shifted. Found two lively *Antiphola*.

Sept. 14. Shifted. Found one lively *Antiphola*; the other one had disappeared.

Sept. 18. Shifted. Found one lively *Antiphola*, but it had not grown perceptibly since Sept 14.

Sept. 22. Shifted. The one remaining *Antiphola* had disappeared.

As I had several larvæ that had spun up among some dry leaves at the bottom of this cage, I did not search among the dry leaves for dead *Antiphola*. The missing ones might therefore have died of the change of food, or they

might have been ichneumonized, or the larger ones might have spun up, or they might have been killed by some of the other larvæ in the cage, which, according to Rev. Mr. Green in his book on "Pupa-digging" is not an unusual circumstance with certain lepidopterous larvæ, or I might possibly have thrown them out by an oversight in changing the leaves; but they could not have escaped through the wire-gauze.

Breeding-cage No. 5. Food-plant *bass.* This, like all the following ones, contained over a cubic foot of space, with the sides and top of musketo-bar, so that occasionally larvæ would make their escape from it by boring through the musketo-bar. There was no earth at the bottom, and only 3 or 4 other larvæ in it, besides the *Antiphola.*

Sept. 5. Placed in it three ½-grown *Antiphola* taken off the oak, all lively.

Sept. 6. Added three more *Antiphola* taken off the oak, two ½-grown and one ¾-grown, all in good order.

Sept. 9. Shifted. Found 3 *Antiphola;* the other 3 had disappeared, and their bodies were nowhere to be seen in the cage. The leaves had partially dried up.

Sept. 10. Found only one *Antiphola;* the other two had disappeared.

Sept. 11—27. The same *Antiphola* throve and grew finely. Sept. 28 it quit feeding and shed its pencils and by Sept. 30 it had spun up.

I believe the 5 missing *Antiphola* in this cage escaped through the musketo-bar, as I found a stray one at large in the room where I keep my breeding-cages on Sept. 3, and two stray ones on Sept. 10. They certainly did not die in the cage, for every time that I shifted the leaves in all the cages but No. 1, I searched carefully for any dead larvæ.

Breeding-cage No. 4. Food-plant *sycamore.* There was no earth at the bottom of this cage, but there were a dozen or two very restless notodontide larvæ in it, that were continually boring through the musketo-bar and escaping.

Sept. 1. Placed in it two lively ¾-grown *Antiphola,* one taken off the oak and another off the elm or possibly the oak.

Sept. 2. Added 3 lively *Antiphola* taken off the oak, one ½-grown and two ¾-grown.

Sept. 3. Returned a stray *Antiphola,* which must have escaped from this cage, as at this date I had no *Antiphola* in any other cage.

Sept. 4. Shifted. Found two living ½-grown *Antiphola,* one of which had just moulted, and found also one DEAD. Two must have escaped, for their bodies were not to be found. Added from Cage No. 1 the abnormal oak-feeding *Antiphola* referred to above, (p. 414) which had now acquired black pencils.

Sept. 5. Added three lively ¾-grown *Antiphola* taken on the oak.

Sept. 9. Shifted. Found three lively *Antiphola,* and also one half-dead and one DEAD. One must have escaped.

Sept. 10. Shifted. Found three living *Antiphola;* the half-dead one was now completely DEAD. Three hours after shifting found three stray *Antiphola* in the room, which had apparently escaped from the cage, and replaced them. In order to identify them, however, I clipped off the tips of their right pencils.

Sept. 11. Noticed one of the clipped *Antiphola* was half-dead.

Sept. 12. The half-dead *Antiphola* was now completely DEAD.

Sept. 13. Shifted. Found no *Antiphola* either dead or alive. Two must have escaped.

Breeding-cage No. 6. Food-plant *sycamore*. There was no earth at the bottom of this cage, and only two or three peaceable larvæ in it on Sept. 13.

Sept. 13. Placed in it one *Antiphola* captured on the oak.

Sept. 14. Added three lively *Antiphola* captured on the oak, one less than ½-grown and two ¾-grown. The one placed there Sept. 13 was still in the cage.

Sept. 15. Shifted. Found three *Antiphola*, including the small one. One of the larger ones had disappeared.

Sept. 17. Shifted. Found three *Antiphola*, including the small one, which was dull and sluggish.

Sept. 19. Shifted. One of the larger *Antiphola* had moulted and was sluggish, the other one was lively. The small one was DEAD.

Sept. 21. Shifted. One of the two remaining *Antiphola* was half-dead, the other one was DEAD.

Sept. 22. The half-dead *Antiphola* was quite DEAD.

Breeding-cage No. 3. Food-plant *oak*. There were 2 or 3 inches of earth at the bottom of this cage, and about a dozen larvæ, besides *tessellaris*, were placed in it from time to time in the forepart of September.

Aug. 31. Placed in it three *tessellaris* captured on the sycamore, two ½-grown and one ¾-grown. They were lively, but their pencils had been badly mutilated in the handling.

Sept. 4. Shifted. All three *tessellaris* had the white tufts on their bodies changed to a decided dirty-white, as in some varieties of *Antiphola*. Their heads were still rufous, and what remained of their pencils was orange and continued so to the last. The large one was vigorous, the two small ones very dull and sluggish.

Sept. 6. Noticed one *tessellaris* DEAD in the cage.

Sept. 9. Shifted. Found one *tessellaris* DEAD; the other one had disappeared and was nowhere to be found.

It thus appears that out of 13 oak and elm feeding *Antiphola* compelled to feed on sycamore leaves, no less than 7 died in from 3 to 7 or possibly 10 days, and 6 either escaped, or were eaten by other larvæ, or possibly might have been thrown out by an oversight in shifting. As they were all well tended and carefully handled, the inference is unavoidable, that *Antiphola*, though it naturally feeds upon a great variety of trees, cannot as a general rule be brought to feed upon sycamore without suffering death in consequence, and therefore that it is not a mere Phytophagic Variety of *tessellaris*. In no one instance could I perceive that any of these *Antiphola* approximated in the color of their tufts towards *tessellaris*, or that their black pencils approximated in the least degree towards the orange pencils of *tessellaris*. It

further appears that out of 3 sycamore-feeding *tessellaris* compelled to feed upon oak-leaves, one died in 6 days and another in 9 days, and the remaining one disappeared; and that four days after they had had their food changed to oak, the tufts on their bodies approximated very remarkably in color to those of *Antiphola*, though their pencils did not. From these facts we may infer that *tessellaris* is not a mere Phytophagic Variety of *Antiphola*.

It is an easy matter for the believers in the Creative Theory to cut the knot, instead of untying it, by asserting that *tessellaris* and *Antiphola* are simply distinct species in their sense of the term, and that they have fed respectively upon the sycamore and upon oak, bass, elm, &c. ever since their original creation. But in that case, assuming the truth of the Creative Theory, how are we to account for the absolute identity of their imagos, and for the further very remarkable fact that these two forms are subject, as I have shown, p. 288, to six or eight distinct variations, which occur equally in each of them? If the coloration of the two forms was plain and simple and without any definite and elaborate pattern, as is the case for example in the dipterous genus *Cecidomyia*, there would be nothing so very wonderful in two distinct species being undistinguishable in the imago, as we find to be sometimes the case in *Cecidomyia*. But the coloration, and more especially the design or pattern of their wings, is so complicated and so diversified, that I could as soon believe that the same pattern could be reproduced twice over in a large and well-filled Kaleidoscope, or that, after distributing the types of a book, they could be re-arranged so as to produce a fac-simile edition, undistinguishable from the first, or that the same identical species had been created twice over in two separate habitats or at two separate geological epochs, as that these two forms were created originally as distinct species by the fiat of the Creative Power. On comparing the two imagos, the impression is irresistible to every unbiassed mind, that there must be a genetic connection between them, or in other words, that they are what I have called Phytophagic Species; which is further confirmed by the fact of the 3 sycamore-feeding *tessellaris* approximating in the coloration of their tufts to *Antiphola*, after feeding only for four days upon oak-leaves. They certainly cannot be mere Phytophagic Varieties, for if they were, out of the sixteen individuals that I endeavored to compel to change their

food from sycamore to oak or *vice versa*, some one of the number would have suffered the change of food without dying; as, out of the six oak-feeding *Antiphola* in Cage No 5, one grew and flourished for 22 days and finally spun up, though its food was changed to bass, and none of the remaining five died in confinement.

CLYTUS (arhopalus) PICTUS Drury (pp. 296—7). I have here demonstrated, that the race that has the habit of preying upon the hickory is distinct from the race that has the habit of preying upon the locust; or, which amounts to the same thing, that a ♀ *pictus* bred in the hickory does not oviposit in the locust. I have also shown that there is a very remarkable difference in their habits, the locust-feeding race, as is well known, coming out in September, and the hickory-feeding race, according to Mr. Bland, in the spring (p. 297, note). Mr. Bland, in reply to some recent enquiries on the subject, has been kind enough to inform me, that "the spring species can be found in abundance upon the hickory the first warm days in May and June, and that it appears to confine itself to this tree; while the fall species appears upon the locust, and can also be taken upon various plants that are in blossom, in September." He adds that "he has made diligent enquiry among the Philadelphia collectors in regard to the time of capture, and they *all* assert that they lose sight of *Arhopalus pictus* from the middle of June until September." Up to the autumn of 1864 I was not aware that any specific distinctions existed between the imagos of these two races, but I have recently ascertained that there are some very remarkable ones in the ♂, though neither Mr. Bland nor myself can discover any in the ♀. I have now before me of the hickory-feeding race four ♂ ♂ three ♀ ♀, one of these ♂ ♂ split by myself out of a stick of hickory wood seven years ago, the other ♂ ♂ ♀ ♀ obligingly communicated to me by Mr. Bland. I have also before me of the locust-feeding race 15 ♂ ♂ 4 ♀ ♀, viz. 13 ♂ ♂ taken *in coitu*, that there might be no possible doubt of their sex, on flowers in September, 2 ♂ ♂ taken in September on the trunk of a locust, 3 ♀ ♀ taken on flowers in September, and 1 ♀ received from Mr. Bland and labelled as belonging to the locust-feeding race. The following distinctions between the ♂ ♂ of the two forms are perfectly constant according to the types, except where otherwise stated.

Hickory-feeding ♂.	*Locust-feeding* ♂.
1. Antennæ, when relaxed and laid close and straight along the back, reaching beyond the tip of the elytra by the whole length of the terminal joint (11.)	1. Antennæ, when relaxed and laid close and straight along the back, even in the specimen which has the longest ones, not attaining the tip of the elytra by a space equal in length to the two terminal joints (10 and 11.)
2. Antennæ from ½ more robust to twice as robust, especially towards the base.	2. Antennæ much less robust, except the few last joints, and less tapered from base to tip.
3. Terminal or 11th joint of antennæ full ½ longer than the penultimate, and composed of two portions connected by an indistinct connate suture foreshadowing a 12th joint, (as in *Purpuricenus* ♂ and in *Tragidion annulatum* ♂ Lec.,) which suture is more distinct on the inferior surface. The basal portion of 11th joint as long as joint 10, the terminal portion, which is suddenly slenderer from base to tip, more than ½ as long as joint 10.*	3. Terminal or 11th joint of antennæ scarcely ⅓ or ¼ longer than the penultimate, the division into two portions barely discoverable, and the terminal portion not suddenly slenderer from base to tip.
4. Elytra widened at base and tapered towards their tip, so that the two together just before the extreme tip equal the basal width of one of them.*	4. Elytra much less tapered and shaped exactly as in the ♀ of both the two races, i. e. with the lateral edges subparallel.
5. The 2nd or W-shaped band on the elytra in two of the Philadelphia specimens and the Illinois specimen whitish, in the other Philadelphia specimen centrally whitish but decidedly varied with yellow on the two exterior arms of the W.†	5. The W-shaped band on the elytra colored yellow, exactly like the other bands, in all my 15 specimens.
6. Legs proportionally ⅓—½ longer and stouter than in ♀.	6. Legs proportionally no longer or stouter than in ♀.

It is a suggestive fact, that although the ♂ antennæ differ so remarkably in the two races both in length, robustness and structure,

* I am indebted to Mr. Bland for directing my attention to these two characters.

† Dr. Fitch says that it was reported to him that individuals reared in the black walnut had the yellow bands on the body more or less white. (*N. Y. Rep.* II. ♀329. With the exception noted in the text they are all bright yellow in the ♂ ♂ bred from the hickory. Mr. Bland remarks that this whiteness of the bands is the exception and not the rule, as it only occurs occasionally at Philadelphia.

the ♀ antennæ are exactly alike, being in both races a little more than ½ as long as the body, with the terminal joint equal in length to the penultimate or perhaps very slightly longer, and no perceptible difference in the robustness of the whole antenna. The general appearance of the two ♀ ♀ and of the ♂ of the locust-feeding race is very similar, but, owing to the shape of the elytra, the ♂ of the hickory-feeding race has a different and *Leptura*-like habit. So closely indeed does the ♂ of the locust-feeding race resemble the ♀ of both races, that until a recent period I had always supposed, that all my specimens of that race — some 30 or 40 in number—were ♀ ♀, and that the unique ♂ which I possessed of the hickory-feeding race was the normal ♂ of the species. In all the ♀ ♀ of both races the W-shaped band on the elytra is as yellow as the other bands. Whether there is any distinction in the larva state is unknown, as the larva of the locust-feeding form has never yet been critically examined. Here again, as in the two *Halesidota*, we find the colorational pattern of the imagos so complicated and diversified, that it is impossible to believe that the two forms have no genetic connection, for the same reasons referred to in the case of the *Halesidota*. That they cannot be mere Phytophagic Varieties, has, I think, been most clearly demonstrated in the paper already quoted.

Whether we choose to consider the locust-feeding and the hickory-feeding forms of this insect as Phytophagic Species, or as distinct species in the sense given to that term by the believers in the Creative Theory, it will be obviously both convenient and necessary to have a separate name for each. It is a doubtful and disputed question in Entomological Archæology, whether Drury's name *pictus* or Forster's name *robiniæ* has the priority, as Drury was the first to describe the insect and Forster the first to name it. We may therefore, with even-handed justice, appropriate the name of *robiniæ* to the locust-feeding race with short and slender ♂ antennæ and legs which appears in September, and the name of *pictus* to the hickory-feeding race with long and robust ♂ antennæ and legs which appears in May and June.

SPHINGICAMPA DISTIGMA Walsh and DRYOCAMPA BICOLOR Harris (pp. 290—294). I have shown here, though there is a certain degree of doubt attaching to the proof, that the ♂ of the former of these two species is undistinguishable from the ♂ of the latter, the ♀ of which is

unknown, while the larva of the former is sphingiform and entirely unlike all known Dryocampa larvæ, and also unlike the aberrant Dryocampade genus *Ceratocampa*, in the abdominal thorns being normally placed, not on every segment, but on alternate segments, and the supposed larva of the latter had the normal Dryocampa form. I have this year met with two larvæ—one of which died and has been preserved in alcohol, and the other either went underground or escaped*—which I believe to be identical with that from which I bred, or supposed that I bred, *D. bicolor*. I am well acquainted with the larvæ of *D. senatoria* Sm. Abb. and *D. stigma* Fabr. and they are certainly quite distinct from my two larvæ; neither do my two larvæ agree with the pretty full description of the larva of *D. pellucida* Sm. Abb. given by Dr. Fitch, (*N. Y. Rep.* II. §324.) the upper dark stripe which is sanguineous in my larva being "dull brownish" in his, and the lower dark stripe, which is also sanguineous in my larva, being "dark olive green or blackish" in his, and there being a "broad dull yellowish stripe" immediately below the spiracles and above the lower dark stripe in his, which has no existence in mine, and a "narrow blackish line on the middle of the back" in his which is not found in mine. There is also a difference in the number of the spines, Dr. Fitch assigning only *six* spines to each segment, instead of *six* to some and *eight* to others; but this is probably nothing but an oversight, as he assigns the same number to *senatoria*, which, unless my memory deceives me, is thorned like my larva on joints 2—11. The only other known N. A. species of *Dryocampa* are *imperialis* Drury, the larva of which is quite different from mine, and *rubicunda* Fabr., the larva of which is undescribed and the imago of which, so far as I am aware, does not occur near Rock Island. I subjoin a full description of my two larvæ, and also a description of the larva of *rubicunda*, with which I have been favored by Mr. J. A. Lintner. It will be seen from comparing these two descriptions, that my larva differs from that of *rubicunda* in the horns of the 2nd segment being proportionally much longer, (for if they were proportionally as short as in *rubicunda* they would be not quite .09 inch long instead of .20 inch.) in the different arrangement and different structure

* It turned out unfortunately, on emptying the earth from the breeding-cage, that it must have escaped.—Nov. 14, 1864.

of the spines, and in having *four sanguineous* stripes instead of *seven dark green* ones. It cannot therefore be *rubicunda*, and hence it would seem to follow that it must be either *bicolor* or some species hitherto undescribed both in the larva and imago states. It is observable that Dr. Harris describes the larva of *pellucida*, of which he professes to have seen only a single specimen, as "pea-green, shaded on the back and sides with red, longitudinally striped with very pale yellowish green, and armed with black thorns," and adds that "it resembles *senatoria* in everything but color," whence it may be inferred that it has about *seven* dark stripes, instead of *four* dark stripes, as *pellucida* is described by Dr. Fitch. I strongly suspect that Dr. Harris described the larva of *rubicunda* as the larva of *pellucida*, taking the darker green as the ground color and the paler green as the color of the stripes, instead of *vice versa* as in Mr. Lintner's description of *rubicunda*. In any case Dr. Harris's description of the larva of *pellucida* differs altogether too widely from Dr. Fitch's description to apply to the same species; for I observe that in the larvæ both of *senatoria* and *stigma* the range of variation is by no means wide, and consequently, according to what I have called the "Law of Equable Variability," we may presume that the range of variation will not be wide in the larva of the closely allied *pellucida*. (*Proc. Ent. Soc. Phila.* II. p. 213.)*

There is another reason, of no great weight perhaps, but still of some weight, why my two larvæ cannot belong to *pellucida*—the only known N. A. species, except *bicolor*, to which they can with any probability be referred. It is often, though by no means universally, the case, that when bright colors occur in the larva the same colors occur also in the imago. For example, the larva of *Deiopeia bella* Drury is said by Drury to be yellow and white dotted with black, like the front wings of the imago; the larva of *Papilio Asterias* Fab. is marked with yellow and black like the imago; and merely from studying the colors of the imago, I foretold that the larva of *Doryphora* 10-*lineata* Say "would probably

* I see from the Preface to the *Iconographie des Coquilles Tertiaires*, published in 1845 by Prof. Agassiz (p. 4), that he practically recognizes the validity of this Law in Conchology; and I learn from a Botanical article in the *Nat. Hist. Review* (1863, p. 192), that very many Botanists practically recognize it at the present day. Important, however, as the Law is, it does not appear to have previously received any name.

be yellow with black spots and markings on its body," which has since turned out to be literally correct. (*Valley Farmer*, July 1862, p. 210 and Sept. 1864, p. 273.) Now my two larvæ are quadrivittate with sanguineous, and the imago of *pellucida* is of a uniform brownish ochreous color, without any sanguineous or rosy-red markings. On the other hand the only N. A. *Dryocampa* that are strongly marked in the imago with sanguineous or rosy-red or dull purple are *imperialis*, *rubicunda* and *bicolor*. *Imperialis* is out of the question, and we know from Mr. Lintner's very full and precise description that my larva cannot possibly be *rubicunda*, whence by the method of exhaustion I infer that it is probably *bicolor*. The fact that Harris describes the supposed larva of *pellucida* as "shaded on the back and sides with red" is another reason why we may conclude that his larva really belonged to *rubicunda* and not to *pellucida*. It is very true that the specimens from which Mr. Lintner drew his description were not thus shaded, but just so some larvæ of *D. imperialis* are "slightly tinged with red on the back," and some are not. (Harris *Inj. Ins.* p. 404.) For the presence or non-presence of a *mere shade* is unimportant when compared with the presence or non-presence of a *stripe*.

In regard to the validity of my new genus *Sphingicampa*, which differs from *Dryocampa*, much as *Attacus* differs from *Saturnia*, in the ♀ antennæ being basally feathered, though less widely so than the ♂ antennæ, Mr. Grote informs me that Herrick Schæffer has figured and described a great number of South American *Dryocampa* which are distinguished by the same peculiarity, but the larvæ of which are at present unknown. Hence it would seem that *Sphingicampa* is more peculiarly a South American genus. Mr. Grote also informs me, that the imago which I described with some doubt (pp. 298–9) as that of *Limacodes scapha* Harris, is, to his personal knowledge, correctly referable to that species.

Dryocampa bicolor? Harris. Larva. Length, when apparently, judging from the size of the head, it was just moulted, 1.20 inch. *Head* greenish yellow, with a brown-black spot bordering the eyes, which are 4 or 5 in number on each side and arranged in a circle open behind; mouth a little varied with brown-black. *Body* very pale greenish-brown, thickly covered and frosted over with small, irregularly placed, whitish granules, none of which are transversely arranged as they are in *stigma*. A pair of dorsal sanguineous stripes, and a lateral sanguineous stripe placed immediately below the line of the spi-

racles, each of these four sanguineous stripes being equal in breadth to one-tenth of the length over the back from proleg to proleg, and the three pale greenish brown stripes between them being each twice as broad as they are; the sanguineous stripes fading out on the anterior submargin of joint 12, and the remaining part of 12 being greenish yellow. Spiracles large, vertically elongate, and black edged by yellowish. On joint 1 behind the head 6 equidistant black tubercles, the outer one pointed at tip, and beneath them a lateral black thorn, all 8 transversely arranged. Joints 2—11 all with 6 transversely-arranged, medial, smooth, acute, black thorns, .03—.05 inch long and sometimes with a few white granules towards their base, two thorns placed between the dorsal sanguineous stripes, one lateral one just outside each dorsal sanguineous stripe, and another lateral one in the lateral sanguineous stripe. On joint 2 the two dorsal thorns are replaced by long, slender, recurved, smooth, obtuse, black horns directed forwards, .20 inch long with a few white granules on their lower half; and on joint 3 the two dorsal thorns are acutely bifid at tip. On joints 2—5 and 10, in addition to the above 6 thorns, there is another one beneath the lateral sanguineous stripe, so that these joints have 8 thorns, all transversely arranged. Joint 12 with one central, dorsal, bifurcate thorn, similar to the two dorsal ones on joint 3, one lateral one on the edge of the superior surface of the joint, and another lateral one below the line of the lateral sanguineous stripe, all 5 black with a few basal white granules and arranged transversely on the anterior submargin, and behind them, half-way to the tip of the lateral edge of the superior surface of the joint, a single black thorn, before and behind which are a few acute whitish granules, and at the tip two greenish yellow thorns tipped with black and directed backwards. Venter very pale greenish brown. *Legs* greenish yellow, the claws brown-black; prolegs pale greenish brown, with a large brown-black spot on their lower exterior surface.—Described from two living specimens. *Food-plant* oak.

Dryocampa rubicunda Fabr. Larva. (Described by J. A. Lintner.) Length 1.70 inch. *Head* reddish-brown; eyes on a crescent black spot. *Body* cylindrical, apple-green, closely dotted with minute, whitish, acute granulations, with a darker green narrow dorsal stripe, and broader subdorsal, lateral and stigmatal stripes, the stigmatal stripe less distinct than the others. Segment 1 with four black tubercles on the collar, the central ones transversely oval, the outer ones subtriangular, a spine in front of the stigma and another at the base of the leg. Segments 2—11 with a substigmatal row of acute, prominent, black spines pointing backwards; a lateral row of shorter ones on the inferior margin of the lateral stripe; a subdorsal row of still shorter ones on the superior margin of the subdorsal stripe, [marked] with whitish at base superiorly; and a ventral row on and in range with the external base of the legs and prolegs, those of the prolegs (segments 6—9) quite small, the other seven (segments 1—5, 10 & 11) nearly as long as the substigmatal ones, except those on the terminal pair of legs, of which there are two on the base of each, which are quite minute. All of the above spines black, the three superior ones in range transversely on the anterior portion of the segment, the substigmatal ones on the middle of the segment. In addition to the above, from the 4th to the 12th segment inclusive,

there is a row of whitish, black-tipped, short spines on the inferior margin of the subdorsal stripe, placed two-thirds of the way to the tip of each segment. Segment 2 has the two subdorsal spines replaced by two black, blunt, spinous horns, placed below the subdorsal stripe and one-eighth of an inch long. The four superior spines of segment 11 more prominent than the corresponding ones of the other segments. Segment 12 with a slightly bifurcate spine on the dorsal line, the size of the lateral ones of the eleventh segment; another in range with the stigmata, the size of the substigmatal ones and having a small branch posteriorly; a small intermediate one ranging with the lateral line; another of the same size ranging with the substigmatal line; and a ventral one similar to and ranging with the ventral spines of segments 10 and 11; making 9 spines on this segment, nearly ranging transversely. Caudal plate triangular, margined externally with eight black spines, the six anterior ones short, the two terminal ones green at base, larger and pointing backward. Stigmata black. *Legs* tipped with black, the anterior pair with a transversely subelliptic black spot on their posterior base, the second pair with a dot similarly placed.—Feeds on sugar-maple.

From the facts referred to above and those recorded by me elsewhere, we may construct the following almost unbroken series, from the first dawnings of the Phytophagic Variety to the full development of the Phytophagic Species.

1st. Difference of food, even when the food-plant belongs to widely distinct botanical families, is accompanied by no differences whatever, either in the larva, pupa or imago state.—*Attacus Cecropia* Lin., *Dryocampa imperialis* Drury, *Lachnus Caryæ* Harris, (*Proc. Ent Soc. Phil.* I. p. 303,) and hundreds of other species.

2nd. Difference of food is accompanied by a marked difference in the color of the silk-producing secretions.—*Bombyx mori* Lin., the common silkworm.

3rd. Difference of food is accompanied by a tendency towards the obliteration of the normal dark markings in the imago.—*Haltica alternata* Illig.

4th. Difference of food is accompanied by marked, but not perfectly constant, colorational differences in the larva, but none whatever in the ♂ ♀ imago.—*Datana ministra* Drury.

5th. Difference of food is accompanied by a marked and perfectly constant difference in the size of the imago.—*Chrysomela scalaris* Lec.

6th. Difference of food is accompanied by a marked difference in the chemical properties of the gall-producing secretions, the external cha-

racters of the ♂ ♀ imago remaining identical.—*Cynips q. spongifica* O. S. and *C. q. inanis* O. S.

7th. Difference of food is accompanied by a slight, but constant change in the coloration of the abdomen of the ♂ ♀ imago, and by a very slight change in the chemical properties of the gall-producing secretions, the galls of the two insects, though typically somewhat distinct, being connected by intermediate grades in the case of the latter.—*Cynips q. punctata* Bassett and *C. q. podagræ* Walsh.

8th. Difference of food is accompanied by one marked and perfectly constant colorational difference, and others which are not perfectly constant, in the larva, but none whatever in the ♂ ♀ imago.—*Halesidota tessellaris* Sm. Abb. and *H. Antiphola* Walsh.

9th. Difference of food is accompanied by several slight but constant structural differences in the ♂ imago, but none whatever in the ♀ imago.—*Clytus robiniæ* Forst. and *Cl. pictus* Drury.

10th. Difference of food is accompanied by a slight but constant structural difference in both ♂ and ♀ imago.—1. *Tingis tiliæ* n. sp. and *T. amorphæ* n. sp. 2. (Doubtful.) *Diapheromera femorata* Say and *D. Velii* n. sp.

11. (Doubtful.) Difference of food is accompanied by very strong structural and colorational differences in the larva and in all probability by a constant structural difference of generic value in the ♀ imago, the ♂ imagos being to all external appearances identical, and the two insects belonging to different genera.—*Sphingicampa distigma* ♂ ♀ Walsh and *Dryocampa bicolor* ♂ Harris.

12th. Difference of food is accompanied by marked and constant differences, either colorational, or structural, or both, in the larva, pupa and imago states.—*Halesidota tessellaris* Sm. Abb. and *H. caryæ* Harris, and hundreds of species belonging to the same genus and commonly considered as distinct species.

The constitution of the human mind is such, that the same evidence carries with it very different degrees of weight, when presented to different intellects. Others will no doubt draw different conclusions from the facts catalogued above; but for my own part, as on the most careful consideration I am unable to draw any definite line in the above series, and to say with certainty that here end the Varieties and here

begin the Species, I am therefore irresistibly led to believe, that the former gradually strengthen and become developed into the latter, and that the difference between them is merely one of mode and degree. If a savage from some newly-discovered island in the Pacific Ocean were shown for the first time in his life a large herd of horned cattle, containing newly-born calves, half-grown calves, yearlings, heifers, steers, cows and bulls of all sizes and ages, he would naturally, I think, arrive at the conclusion that they were all modifications of one animal, though he had no opportunity, as we have, to watch from day to day the calf develop into the yearling, the yearling into the heifer, and the heifer into the cow. So with the gradual development of the Variety into the Species. We cannot, from the shortness of human life, see the *same* identical species develop gradually from century to century, first into slight varieties, then into marked varieties, then into geographical or phytophagic races, then into new species; but in one and the same year we may see all the stages of development, with all the possible intermediate grades, in *different* species; and to shut our eyes to the validity of this the only possible proof under the circumstances, and to maintain that Species were created and Varieties have made themselves, and that the two categories are therefore essentially distinct, is as if the imaginary savage from the South Seas, ignoring or overlooking the presence of the yearlings and heifers, were to come to the conclusion that calves and cows are distinct species of animals. Darwin never spoke a truer word than when, referring to certain naturalists who believed in the essential difference between Species and Varieties, and yet published the very same identical form one year as a Variety and the next year as a Species, he said that "the day will come, when this will be given as a curious illustration of the blindness of preconceived opinion." (*Orig. Sp.* p. 419. Am. edit.)

Rock Island, Illinois, October 24, 1864.

POSTSCRIPT.

In my Paper in the *Proc. Bost. Soc. Nat. Hist.* (p. 289), referring to the fact that Dr. Harris says that the Caterpillar of *Halesidota tessellaris* "is not correctly represented in Smith and Abbott's *Insects of Georgia*," I suggested that "possibly the Caterpillar of *Antiphola* may

be there represented." I have recently heard from Mr. Grote as follows, which fully confirms that conjecture.

"The figure of *Halesidota tessellaris* in the larval state, as given by Abbott and Smith, represents the hairs, and so far as perceivable the body, as of a dull, ochraceous brownish color. The dorsal tufts show a superior dark brown shade and a blackish line. The lobes of the head are bluish black; the legs with a reddish shade. The four long anterior pencils are blackish with a faint brownish tinge, and the two terminal pencils are similarly colored. The larva is represented on Fagus ferruginea [beech], and is stated also to be found on hornbeam and plum trees."

Hence it is, I think, very evident that *tessellaris* Abb. Sm. is identical with my *Antiphola*, and *tessellaris* Harris *non* Abb. Sm. a hitherto unnamed (Phytophagic) species, for which I propose the name of *Harrisii*. The black and not rufous head, the black and not orange-colored pencils, and the ochraceous brownish and not milk-white hair of the larva of *tessellaris* Sm. Abb. seem to settle that point effectually. Moreover that larva is not stated to feed on sycamore (Platanus occidentalis), on which alone the *tessellaris* of Harris is known to feed according to Harris, Edwards, Lintner and myself, but on a variety of other trees like my *Antiphola*.

We can understand now, I think, why Dr. Harris described the larva of his *tessellaris* as "yellowish or straw-colored," whereas it is in reality milk-white. He evidently perceived the apparent identity of his *tessellaris* (imago) with the *tessellaris* (imago) of Abbott and Smith, and very naturally supposing the larvæ to be also identical, modified his description of the larva so as to make it something intermediate between the two species.—Nov. 16, 1864.

ERRATUM.

Page 414, lines 10 and 11, for "white pencils" read "white pencils on the 2nd segment."

ON PHYTOPHAGIC VARIETIES AND PHYTOPHAGIC SPECIES,

with remarks on the Unity of Coloration in Insects.

BY BENJ. D. WALSH, M. A.

DATANA MINISTRA, Drury. (Lepidoptera.)

Messrs. Grote & Robinson (*Proc.* &c. IV. p. 491) seem to be of opinion, that the black larva found on the hickory may produce a different species of *Datana* from the yellow-necked and striped larva found on the oak, the apple, &c. The objection to this hypothesis is, that a larva intermediate between these two forms, viz: with the longitudinal stripes but without the yellow neck, occurs, as I have already stated, (*Proc.* &c. III. p. 403) both on the hickory and on the oak. Mr. Lintner indeed tells me, that from the black larva found on the hickory he reared what he considers as the *D. contracta* of Walker; but from this same black larva I myself reared the normal form of *ministra*, (*ibid.*) and also other forms which approximate in some of their characters towards *contracta* Walker and towards *perspicua* Gr. Rob. In fact I have little doubt that both these last so-called species are mere varieties of *ministra*, based upon extreme specimens. For the distinctive characters, which are assigned to each of them, are not found exclusively in one set of specimens bred from one kind of larva, but occur promiscuously, with all the intermediate grades, sometimes in one set of specimens, sometimes in another, as I shall now proceed to show.

According to Walker as quoted by Morris (*Synop.* p. 247) *Datana contracta* differs chiefly from *D. ministra*, 1*st*, in having narrower front wings; 2*nd*, in the brown wing-bands being edged externally with whitish-tawny; 3*rd*, in the second wing-band being nearer the first on the hind border of the wing. As to the *first* distinctive character, I have before me, *a* Fitch's figure of *ministra*, (*N. Y. Rep.* I. Pl. iv. 3,) *b* Harris's figure of *ministra*, (*Inj. Ins.* Pl. vi. 6,) *c* 1 ♂ and *d* 1 ♀ bred by myself from the normal yellow-necked larva found on the oak, *e* and *f* 2 ♂ and *g* and *h* 2 ♀ bred from the black larva found on the hickory, and *i* one captured ♀. On the most careful measurements of all these, I find that, making the extreme breadth of the front wing 100, its proportional length is in *a* 191, in *i* 192, in *c* 195, in *b* 200, in *g* 202, in *h* 208, in *e* 211, in *f* 212, and in *d* 213. Evidently, therefore, this character is too variable, and connected by too many intermediate grades, to be of specific value. As to the *second* distinctive character, it is absent in *a*, *b* and *h*, faint in *c*, moderate in *e* and obvious in *d*, *f*, *g* and *i*.

Here again, therefore, there are too many intermediate grades to make the character worth anything. As to the *third* distinctive character, making the length of the wing 100 in each of the above, the proportional distance of the first wing-band from the second wing-band on the hind border of the wing, from centre to centre, is in *d*, *e* and *g* 5, in *c* 7, in *i* and *h* 9, in *f* 10, in *b* 15, and in *a* 16. In other words this character is proportionally three times as strong in some specimens as in others, with intermediate grades from one to another. In *perspicua* Gr. Rob. this proportional distance is equal to nothing, the first wing-band being confluent behind with the second. Yet, although this seems the most remarkable of the abnormal characters concentrated in *perspicua*, it is not enumerated by Grote & Robinson among the distinctive characters of that so-called species. It may be added here, that Walker gives it as a character of *ministra*, but not of *contracta*, that "the space between the first and second wing-band is a little darker than the wing elsewhere," whereas Fitch calls this form variety *e* of *ministra*, and in fact this character is absent in *a*, *b* and *h*, very faint in *c* and *e*, moderate in *d* and *g*, and obvious in *i* and *f*; and is said likewise to occur in *conspicua* Gr. Rob. Here again, therefore, it is impossible to draw a definite line anywhere. Moreover Walker gives it as a sexual character of the ♂ *ministra* that it has *one* discal brown spot, and of the ♀ that it has *two* discal brown spots in the front wing. Whereas it is proved by the specimens now before me, that the presence or absence of one or both discal spots is not a sexual character at all. Evidently this author has described, not the *species*, but the *individual*, and must have worked on a very limited number of specimens.

According to Messrs. Grote & Robinson *D. conspicua* "may be quickly distinguished from the hitherto described species of the genus, 1*st* by its more yellow color, 2*nd* by the narrow anterior wings, 3*rd* by the transverse lines not bordered with paler shades, 4*th* by the produced apices [of the front wings], 5*th* by the obsolete irrorations [of the front wings], 6*th* by the wider terminal space and the more crowded transverse lines." (*Proc.* &c. IV. p. 490.) To take up these characters in order, 1*st* in a colored impression of Mr. Grote's figure of *perspicua*, obligingly furnished to me by that gentleman himself, the color of the front wing is only a shade or two yellower than in *c* and *g*, and Fitch correctly states that in *ministra* "the fore wings vary from pale buff yellow to russet and auburn brown." (*N. Y. Rep.* I. p. 239.) 2*nd*. Taking Mr. Grote's figure of *perspicua* as correct, and making the extreme breadth of its front wing 100, its proportional length is only

208, or considerably *less* in proportion, instead of *much more*, than it is in *e*, *f* and *d*. (See above under the first distinctive character of *contracta*.) 3*rd*. See above under the second distinctive character of *contracta*. 4*th*. In the figure of *perspicua* the apex of the right front wing is scarcely produced at all, and that of the left front wing but very slightly. In *h* they are produced fully as much as in the above figure, and in *i* the right wing is produced a great deal more, with a deep excavation behind the apex, and the left wing not at all, with no excavation whatever behind it. 5*th*. In *d* the irrorations are obsolete, and subobsolete in *c*. 6*th*. Making the length of the front wing 100, the proportional distance from the middle of the terminal fringe to the middle of the subterminal wing-band, from centre to centre, is in *g* 15, in *i* 17, in *a* and *b* 18, in *e* 19, in *c*, *d* and *f* 20, and in *h* 22. In *conspicua*, according to Mr. Grote's own figure, it is only 21, or *less*, instead of *much more*, than it is in *h*. Consequently all the above distinctive characters are connected by intermediate grades, and therefore worthless. Neither is it true, as is stated in the description of *perspicua*, that *ministra* differs from *perspicua* in the brown color of the anterior part of the thorax always "extending unicolorously over the prothorax." For in *d* and *g* the anterior part of the brown patch is distinctly ferruginous, and in *f* and *i* it is less obviously so. Indeed Fitch describes *ministra* as having always "the fore part of the thorax bright orange or tawny yellow, this color being deeper or brownish towards its posterior edge." Like Mr. Walker, Messrs. Grote & Robinson seem to have had but a very poor supply of material to work on.

On the whole, even in the few specimens now before me, the above characters are so inextricably intermixed, that if *contracta* and *perspicua* are distinct species, then every one of the seven specimens before me must also be a distinct species. The truth of the matter seems to be, that *ministra* is a very variable species, and that collectors, as they usually do, have seized hold of a few extreme varieties and forwarded them to systematists, who have thus been deceived into treating those extreme varieties as species. *Datana conspicua* is confessedly founded upon a single specimen, and we have but to refer to Dr. Fitch's *Vanessa Lintneriі* and *Nathalis Irene*, in order to perceive how dangerous it is to found new species upon solitary specimens of variable species. As to the former species, Dr. Morris concedes that it is probably a variety of *Antiopa*. As regards the latter, a few years ago *Nathalis Iole* swarmed near Rock Island; and I took in profusion in company with each other all the intermediate grades between the nor-

mal *Iole* and Fitch's *Irene*, and many other varieties besides. Indeed Mr. Edwards, to whom I have forwarded most of the above varieties, expressly asserts that "*Irene* Fitch is simply *Iole* with a trifling variation." (Morris *Synop.* p. 351.) Just in the same way Dr. Harris made five species out of the very variable Orthopterous *Tetrix ornata* Say, and Dr. Fitch has made three species of the Homopterous genus *Athysanus*—*variabilis*, *fenestratus* and *minor*—out of a single wonderfully variable one, which I have found in profusion on the same birch tree in the three forms quoted as species by Dr. Fitch, together with all the intermediate varieties, and enough others, not noticed by Dr. Fitch, to make a dozen species as good as his.

Taking all the facts into consideration, I do not think that we are entitled to assume that the black larva found on the Hickory is what I have called a Phytophagic Species—i. e. that it has ceased to intercross commonly in the imago state with the normal form found on other trees —but only that it is a Phytophagic Variety. In the course of an indefinitely long time, it may perhaps cease to intercross with the normal form; and then by the Laws of Inheritance the distinctive characters, which are now connected by intermediate grades, will cease to be so connected, and the Hickory form will become to all intents and purposes a true (Phytophagic) species. We find a good exemplification of this stage in the process in the following species.

Halesidota* tessellaris Sm. Abb. (=Antiphola Walsh) and H. Harrisii Walsh (=tessellaris Harris *non* Sm. Abb.) (Lepidoptera.)

I have this year carefully compared several dozen larvæ of the above two (Phytophagic) species, and find that the mature and nearly mature

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*As to the orthography of this genus, Mr. Grote has the following remarks:—"Mr. Walker, in transcribing the generic name *Erinnyis* from Hübner, has altered it to *Erinnys—for what reason I know not.* As is the case with *Halisidota* and *Amplypterus*, which read *Halesidota* and *Amblypterus* in the Cat. B. M., *I presume it is the result of a simple error of transcription.*" (*Proc.* &c. V. p. 79.) Clearly, in all these three cases, it is no casual error of transcription, but a rectification of Hübner's bad Greek. Authors of course are at perfect liberty to coin gibberish generic names; and so far as my own private tastes are concerned, I infinitely prefer a good, sonorous, gibberish name, such as *Rembus, Clambus, Agabus, Datana, Nadata*, &c., to the general run of would-be Greek ones. But when a generic name is manifestly intended to be Greek—and more especially when a Greek derivation is printed along with it, so as to prevent us, which we should otherwise often do, from considering it as gibberish—most writers conceive that they are at liberty to spell it correctly, and reduce it to

individuals of each differ constantly by the characters given in the following Table. The very young larvæ, i. e. .15—.20 inch long, are scarcely distinguishable, being each of them without any pencils, and each of them having the head yellowish-white, but rather yellower in the former than in the latter, and the dorsal integument yellowish-white, with the warts brown-black as in the mature *Harrisii*. But so soon as ever they obtain pencils, which is probably after the first moult, the two middle pencils on segment 3 are invariably black in *tessellaris* and invariably orange-color in *Harrisii*, although occasionally in individuals, which are less than half grown, the other colored pencils incline more or less towards white. The color of the hair is, as I formerly supposed, normally white in *Harrisii*, but a few individuals occur with the hair of a dirty white like that of the normal *tessellaris*. On the second segment there is in *Harrisii* but a single distinct white pencil under each orange one, the second white one, which is very distinct in *tessellaris*, being confounded with the long hairs overhanging the head. (See *Proc.* &c. III. p. 414.) And the white pencil on segment 12 is much less obvious in *Harrisii* than in *tessellaris*, and generally almost obsolete, being confounded with the long hairs overhanging the anus.

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something like a grammatical form. Some years ago the Editors of Silliman's Journal, having occasion to rectify the orthography of one of Prof. Owen's scientific terms, which was manifestly intended for Greek, observed that it was right and proper to do so, however long and universally the term had been in use.

Even authors who maintain, that under no circumstances is it allowable to change a single letter in a published name, unless that name be preoccupied, do not always practice what they preach. For example, Osten Sacken, who avows this doctrine as the true scientific faith, has recently omitted the letter *q* (*quercus*) in the specific names of a whole host of the *Cynipidæ* of the Oak, professedly "because this addition seems perfectly useless." (*Proc.* &c. IV. p. 344.) It may perhaps be useless, as applied to the *insect*, but as applied to the *gall*, which is usually designated by the specific name of the gall-maker, it seems to me to answer a very useful and desirable purpose, *i. e.* to specify on what genus of plants the gall grows. Otherwise who is to distinguish between the Cynipidous gall "[Q.] tubicola O. S.," which grows on an Oak, and the Cecidomyidous gall "Tubicola O. S.," which grows on a Hickory? But be this as it may, if we have no right to change *Amplypterus*, which is impure and barbarous Greek, into *Amblypterus*, which is pure Greek and means "obtuse-wings," we certainly have no right to change *Cynips q. forticornis*, which is neither preoccupied nor grammatically objectionable, into *Cynips forticornis*. We might just as reasonably change such elegant specific names as *acerifoliella* (maple-leafling) and *rhoifructella* (sumach-fruitling) into *foliella* and *fructella*.

	H. tessellaris, mature larva.	H. Harrisii, mature larva.
Head	black.	rufous.
Dorsal integument	greenish-black,	yellowish-white, with the warts and a ring round each spiracle brown black.
The two middle pencils on segments 2 and 3	black,	orange color.
The two pencils on segment 11	black,	milk-white.

Now if, in the imagos of any two insects, we found constant distinctive characters one-quarter as strong as the above, no entomologist would hesitate for a moment to pronounce them distinct species. For example, *Colias Philodice* Godt. is universally, and with justice, allowed to be distinct from *C. Eurytheme* Bdv., although the only constant character that separates them is, that the first has sulphur-yellow wings and the last orange-colored wings. Yet how slight is the difference between sulphur-yellow and orange-color in these two species, when compared with the difference between the black pencils of *tessellaris* and the orange-colored or milk-white pencils of *Harrisii!* And how can we consistently rely upon a single constant character to separate two imagos, if we refuse to acknowledge the validity of four constant distinctive characters to separate two larvæ?

It is easy to say that one of these two forms is a mere "larval variety" of the other; (see *Proc.* &c. III. p 536;) but those who use such language misunderstand the very meaning of the term "variety." True it is that many larvæ vary astonishingly; but then in their case, as in every ordinary variety, we find the intermediate grades also. While here, as regards the four distinctive characters pointed out above, out of scores of specimens of the mature or nearly mature larvæ that I have examined, I have not found a single one that presented any intermediate grade whatever.

No entomologist hesitates to consider two imagos as distinct species, merely because the larvæ are undistinguishable. In many families, indeed, e. g. *Cynipidæ*, *Apidæ* and *Muscidæ*, very many larvæ bear so close a resemblance to each other, that he would be a bold man who pretended to distinguish them. Why then refuse to consider two well characterized larvæ, like *tessellaris* and *Harrisii*, as distinct species, merely because their imagos are undistinguishable? Why lay all the stress upon the characters of the imago, and none at all upon those of the larva or pupa? This is as irrational, as if an entomologist were to cut off and throw away the wings and legs of every imago which he is studying, and persist in classifying it from the consideration of its body

alone; much in the same way as Conchologists used formerly to neglect and undervalue all the soft parts of a Mollusk, and decide on its systematic affinities only from the characters of its shell.

But although it is difficult to assign any good reason for making the imago the sole criterion of specific identity, it may be readily understood how the practice originated. The imago is easily preserved so as to retain its characters unimpaired; the larva is preserved with difficulty, and frequently cannot be preserved at all without losing its shape and its color. The imago may be collected vicariously, and studied in the closet a thousand miles from its habitat; in order to study the larva, the naturalist must, in many cases, go forth personally into the woods and the fields, and contemplate the living animal on the very spot of ground where, and at the very time of year when, it is to be met with. Hence the imago with many systematists has become everything, the larva and pupa nothing. But if it so happened that larvæ were easily preserved in cabinets, and imagos with difficulty, then it is not improbable that closet-naturalists would neglect and undervalue the characters of the imago, just as many of them now neglect and undervalue those of the larva. Genera and species would then be characterized almost exclusively from the consideration of the larva, just as they now are characterized almost exclusively from the consideration of the imago; and entomologists would be no more disconcerted at finding two distinct species undistinguishable in the imago, than they now are at finding two distinct species undistinguishable in the larva state.

On the general principle that, whenever two insects differ by constant and well-marked characters in any of their states, whether egg, larva, pupa or imago, they must be specifically distinct, unless they be the sexes or other dimorphous forms of one and the same species, the case of *tessellaris* and *Harrisii* might be rested here. But there is additional evidence of their specific distinctness. The former occurs upon a great variety of trees—oak, basswood, elm, hackberry, hickory, thorn, soft maple, and, according to Abbot, on beech, hornbeam, and plum—but never, as I have this year carefully noticed, upon sycamore, (platanus;) the latter occurs exclusively upon sycamore. At first sight we might account for these facts, upon the hypothesis that the colorational peculiarities of *Harrisii* are due to its feeding upon sycamore; and that if a young *tessellaris* were fed upon sycamore, it would gradually, as it approached maturity, pass into *Harrisii;* in other words, that the two so-called species are mere Phytophagic Varieties. But experiment demonstrates the fallaciousness of this supposition. I have this year suc-

ceeded in forcing two out of twenty-seven *tessellaris* to feed upon sycamore for about forty days, till they finally spun up; yet to the very last they retained all their own distinctive characters, and showed not the slightest disposition to assume those of the other species. What is very remarkable, out of forty-three *Harrisii* that I fed this year upon oak, not a single one lived to spin up; but so long as they remained alive in the breeding-cage, which was on the average about five days, the only approximation that they made towards *tessellaris* was, that their hairs (not their pencils) generally became of a dirtier white.

In order to judge of the effects of food upon these two insects, I have this year tried the following experiments under precisely similar conditions, and with every possible precaution to guard against error. 1*st*. I fed upon oak a lot of *tessellaris* found upon Oak, in Breeding-cage No. 3. 2*nd*. I fed upon Oak a lot of *tessellaris* found partly on Thorn, partly on Basswood, and partly on Hickory, in Breeding-cage No. 4. 3*rd*. I fed upon Sycamore a lot of *tessellaris* found partly on Oak and partly on Basswood, in Breeding-cage No. 5. 4*th*. I fed upon Oak two distinct lots of *Harrisii* found upon Sycamore, in Breeding-cages Nos. 6 and 7. An accurate record was kept of the phenomena presented by each lot, which, for the sake of brevity and for the convenience of comparisons, has been reduced to the following tabular abstract. About three-fourths of the larvæ in each lot were quite young, ranging from .30 to .50 inch in length, and scarcely any were admitted that appeared to be more than half grown.

	Number of larvæ fed.	Percentage found in Breeding-cage			Average* number of days when found		
		dead	missing	spun up	dead	missing	spun up
HALESIDOTA TESSELLARIS.							
No. 3 Retained on Oak	20	15.0	50.0	35.0	5.0	16.1	29.9
No. 4 Shifted on to Oak	23	0	86.9	13.1	0	17.1	33.7
No. 5 Shifted on to Sycamore	27	11.1	81.5	7.4	5.7	5.7	40.0
HALESIDOTA HARRISII.							
No. 6 Shifted on to Oak	23	47.8	52.2	0	5.4	2.5	0
No. 7 " " "	20	30.0	70.0	0	4.7	4.3	0

*I give here and elsewhere what is, strictly speaking, the average number, and not the medium number. The two things are often confounded together, but are quite different. For example, if one larva dies in 4 days and three die in 8 days, the *average* number of days is seven, but the *medium* number is six. I suspect that certain writers, who profess to give the average dimensions of insects, give, in reality, nothing but the medium dimensions. To calculate the average dimensions of forty or fifty specimens, requires that every one of the forty or fifty should be measured. To calculate the medium dimensions, all that is necessary is to measure the smallest and the largest.

Hence we may conclude 1st, that *tessellaris* may, without very material injury to its health, be shifted on to Oak from the other trees on which it naturally feeds; for although, of those that were retained on Oak, a much larger percentage spun up than of those that were shifted on to Oak from other trees, yet a considerable percentage of the former, and none whatever of the latter, died in confinement. *2nd.* That Sycamore is not a congenial food for *tessellaris;* for a considerable percentage of those fed on Sycamore died in confinement, and but a small percentage spun up. *3rd.* That Oak is abhorrent to *Harrisii* as a food-plant.—It may seem strange at the first view, that *tessellaris* can be compelled to feed upon Sycamore up to the time of its assuming the pupa state, and *Harrisii* cannot be compelled to feed for any length of time upon Oak; but when we consider that in a state of nature the former is polyphagous and the latter monophagous, our surprise will cease. It is not that *Harrisii* does not eat the oak-leaves furnished to it—for the quantity of excrement on the floor of the Breeding-cage at each shifting and cleaning out proved that it must eat them—but that, having eaten them, it either perishes of disease superinduced by the unnatural food, or bores its way out in despair through the millinet of the Cage, or devours its own brethren in default of its natural food-plant.

It will be observed from the Table that in Nos. 5, 6 and 7 the average number of days when the larvæ were found missing is small, being only a little over four days; whereas in Nos. 3 and 4 it is large, being a little over sixteen and a half days. The reason of this difference is, that in the former, as soon as the larvæ were placed on the leaves, they commenced endeavoring to escape; whereas in the latter, they mostly staid contentedly on the leaves until they were full-grown, when many escaped from the Breeding-cage, probably in search of a more convenient place in which to spin up.

On the whole—however disagreeable it may be to systematists to concede, that two perfectly distinct insects may be undistinguishable in the imago state, and consequently that something more is necessary, towards the definitive establishment of specific distinctions, than the mere comparison of cabinet specimens of the imago—we must, I think, in view of all the above facts, decide that *tessellaris* and *Harrisii* do not belong to the same species. If, indeed, we first lay it down as a law, that all forms that are undistinguishable in the imago are identical, then all such facts as the above will go for nothing. But to do this is merely begging the question and arguing in a vicious circle. We might

just as reasonably first lay it down as a law, that all imagos that have abdomens of the same size, shape and color are identical, and then torture Nature to fit the Procrustean bed, which we have predetermined in our own minds that she shall lie upon, whether or nay.

There is a partial parallel to the case of these two *Halesidota* in the "alternate generations" of certain Radiata. "It is curious," we are told, "that while very dissimilar Jelly-fishes may arise from almost identical Hydroids, we have the reverse of the proposition, in the fact that Hydroids of an entirely distinct character may produce similar Jelly-fishes." (*Seaside Studies* by E. C. and A. Agassiz, p. 43 and see p. 75.) Here two given lines either diverge after converging, or converge after diverging. But in *Halesidota* the lines first converge, then diverge, and then converge again. For it has been shown, that the very young larvæ of *tessellaris* and *Harrisii* are very nearly or quite undistinguishable, that the mature larvæ differ as widely as any two species of the same genus can well do, and that finally the imagos become absolutely undistinguishable.

On the supposition that *tessellaris* and *Harrisii* sprang from the same pre-existing species, and consequently that they were primordially undistinguishable in the larva state, as they still are in the imago; we may account for their larval differences by assuming, that the colorational peculiarities of the two larvæ afford them a partial protection against birds and against ichneumon-flies and other predaceous insects, and were gradually assumed on the Darwinian theory of Natural Selection. We know how many lepidopterous larvæ are partially protected from birds &c. by simulating twigs or the bark of the tree on which they live; and it is not at all impossible that the orange pencils &c. of *Harrisii* and the black pencils of *tessellaris* may be mistaken by birds and insects for a process of the particular plants on which they feed. If we reject this assumption, we can only attribute the differences of the two larvæ to what Darwin calls "Divergence of Character," superinduced by breeding "in-and-in" for ages; in the same manner as geographical varieties come to differ in process of time from one another and from the original type.

SPHINGICAMPA DISTIGMA Walsh and DRYOCAMPA BICOLOR Harris. (Lepidoptera.)

Having been fortunate enough to meet this year with three larvæ exactly similar to that which I have described as *D. bicolor*, (*Proc.* &c. III. p. 425,) I had hoped to solve definitively the question of what imago they would produce. Being confined, however, in a cage with millinet

sides, they all three bored through the millinet and escaped; and I now recollect that the thirty or forty *Dryocampa*, that I have bred in different years, were all bred in a cage with sides of wire-gauze; although, singularly enough, I bred my *S. distigma* in a millinet cage, and not a single larva of some twenty that I had on hand, bored its way out. The above question, therefore, must remain for the present in abeyance; but I clearly ascertained that the *bicolor* larva is not the immature form of some other *Dryocampa*—*stigma* or *rubicunda* for example —for all my three specimens retained their peculiar colorational and structural characters up to the date of their disappearance.

ARHOPALUS ROBINIÆ Forst. Walsh and A. PICTUS Drury Walsh.

(Coleoptera.)

The larva of *pictus* has been fully described and figured by Osten Sacken. (*Proc.* &c. I. pp. 121–2.) That of *robiniæ*, as I have already observed, has never yet been fully described. On June 29 I procured six of them, .55—.75 inch long, from a branch of locust one and a half nch in diameter, which they had completely honeycombed, heartwood and all. They differ in the following particulars from *pictus* as described by Osten Sacken:

1*st*. They have very distinct, though small, brown-black legs, the first pair placed halfway from the centre of the sternum to the lateral edge, and upon that fleshy, transverse fold behind the prosternum and separated by a furrow from it, which is said by Erichson to occur in all *Cerambycidæ;* the third pair on the metasternum in range with the first; the second pair on the mesosternum considerably inside of a line connecting the first and third. This latter arrangement is probably due to the thoracic spiracle being, as in all *Cerambycidæ* as distinguished from *Lamiidæ*, located on the mesothorax and so crowding the leg inwards. Each leg is conical, not quite .02 inch long, with a basal diameter of over .01 inch, and 3-jointed, with the last joint a little prolonged in a slender thorn. According to Erichson as quoted by Osten Sacken, all Longicorn larvæ, except those of *Lamiidæ*, "have feet, which, however, are sometimes so small as to be perceptible only when magnified even in large-sized larvæ." (*Proc.* &c. I. p. 119.) Yet not only does Osten Sacken describe and figure the larva of *pictus* as apod, but he expressly says that "the larva of *Arhopalus* has no feet, although belonging to the *Cerambycidæ*." (*Ibid.*) Can it be possible, that of two such closely allied species as *robiniæ* and *pictus*, one is apod in the larva state and the other has distinct feet? Or are the feet mi-

croscopically minute in *pictus*, so that they were inadvertently overlooked by Osten Sacken?*

2*nd*. When alive these larvæ were not at all clavate in front, neither were the thoracic segments flattened above and below, as the larva of *pictus* is described and figured by Osten Sacken, most probably from alcoholic specimens. Yet after being immersed in alcohol for three and a half months, both these characters made their appearance, although the prothorax is still, as compared with the middle abdominal joints, only as thirteen to eleven wide, even in the most strongly clavate specimens, whereas Osten Sacken figures that of *pictus* as in the proportion of thirteen to seven. Since, however, he describes the prothorax of *pictus* as "twice broader than long," which is also true of *robiniæ*, the above difference is probably due to his specimens having been preserved in too strong alcohol, so as to shrivel up the abdomen unduly.

3*rd*. When recent, the prothorax is not "brownish-yellow," but whitish like the rest of the body, with four transversely arranged, roundish, brownish-yellow, dorsal spots. In the alcoholic specimens, the entire body assumes a more or less brownish tinge on the dorsal and ventral surface, which is less obvious laterally; but even then the prothorax is usually no darker than the rest of the body.

Besides the above two (Phytophagic) Species, there is a third species

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* Baron Osten Sacken has obligingly sent me one of the larvæ from which his description was drawn, and which, as he says, was communicated to him by Dr. Horn, "along with the pupa and the recently escaped imago;" and it absolutely has no feet at all and no vestiges of any feet, under the most powerful lens. Now, even if we assume that Dr. Horn was mistaken as to the identity of his larva, which, as Baron Osten Sacken well suggests, can scarcely have been the case, to what imago could it pertain? If it pertained to any other Cerambycide—e. g. *Chion garganicus* Fabr. which is our commonest hickory borer—then there is the same anomaly of a Cerambycidous larva without any feet. If it pertained to a Lamiide—e. g. *Monohammus tigrinus* DeGeer, which, according to Dr. Fitch, commonly inhabits the hickory in Pennsylvania—then we have the other anomaly of a Lamiidous larva with its thoracic spiracle, not where according to Erichson it ought to be, viz: in the fold between the pro- and mesothorax, which fold as it bears the front legs in *robiniæ* must necessarily be prothoracic and not mesothoracic, but on the side of the mesothorax as in *Cerambycidæ*. For not only does Osten Sacken describe his larva as having the "spiracles normal," but I see with my own eyes that its thoracic spiracle is on the side of the mesothorax. On the whole, I incline to believe that the larva of *A. pictus* is really apod, and that of *A. robiniæ* really 6-footed; but as this is so remarkable an anomaly, it would be very desirable to verify the facts by further observations. Mr. Cyrus Thomas describes a larva found in locust wood, which he supposes to be that of *A. robiniæ*, as having "six very minute feet." (*Trans. Ill. State Agr. Soc.* V. p. 430.)—Dec. 16, 1865.

of *Arhopalus*—the *infaustus* of LeConte, as kindly determined for me by that author himself—the ♂ and ♀ of which are as much alike as those of *robiniæ*, and scarcely differ from my specimens of that species ♂ ♀, except in the yellow bands being nearly twice as wide and the antepenultimate one at the tip of the elytra nearly thrice as wide, and in the legs being brown-black instead of ferruginous. With the exception, however, of the antepenultimate one, the yellow bands of this species are no wider than in Harris's figure of *robiniæ*. (*Inj. Ins.* Pl. II. 10.) Besides the above colorational characters, there is a very slight, but constant, structural character which distinguishes *infaustus* both from *pictus* and from *robiniæ*. In the former ♂ ♀ the antennal joints 2 and 3 are together ¼—⅓ *shorter* than joint 1; in the two latter species ♂ ♀ they are *equal* to joint 1. Of *infaustus* my friend Dr. Velie took in the middle of September, 1864, eight ♂ four ♀ on the Platte River in Colorado, near Baker's Ranch; and as both he and Dr. Parry, the Iowa botanist, agree that there were no trees but cottonwoods growing within a great many miles of that locality, the presumption is that that insect inhabits the cottonwood. In that case we have here a third (Phytophagic) Species belonging to this group, which agrees with *robiniæ* in all the six ♂ characters that separate that species from *pictus*, (*Proc.* &c. III. p. 421,) and also in the time of the appearance of the imago; but differs ♂ ♀ as specified above from *pictus* ♂ ♀ and *robiniæ* ♂ ♀, and also in its food-plant.

CALLIDIUM ANTENNATUM Newman (=violaceum Eur?) and C. IANTHINUM Lec. (Coleoptera.)

The former of these two very closely allied species lives in pine wood, according to Harris, and comes out from the middle of May to the first of June. (*Inj. Ins.* p. 100.) Of the latter, as determined by Dr. LeConte himself, Dr. Velie took ten specimens in Nebraska in the month of May in and on Red Cedar, which tree they were infesting in enormous numbers. Hence the two may be considered as Phytophagic Species. *Ianthinum* differs as follows from *antennatum* on comparison with 2 ♂ 1 ♀ of the latter received by me from the Eastern States:—

1*st*. The length (ten specimens) is .39—.45 inch instead of .55—.60 inch, or, according to Harris, .40—.60 inch.

2*nd*. The thorax is only one-third shorter than wide instead of one-half shorter.

3*rd*. The widest part of the thorax is a little *behind* the middle instead of a little *before* the middle.

4*th*. The sculpture above is, not only relatively, but absolutely coarser, especially on the thorax.

5*th*. On the pronotum ♂ there is no subpolished dorsal shield, bounded laterally by a distinct unidentate stria. Dr. LeConte informs me that this character is always met with in ♂ *antennatum*, and it is very conspicuous in both my ♂ ♂. I have been unable to ascertain, what are the characters which are supposed to separate our *antennatum* from the European *violaceum*, which also feeds on pine, and with which it was formerly confounded. The name seems to indicate that there is supposed to be some difference in the size or structure of the antennæ.

CONOTRACHELUS NENUPHAR Hbst. (Coleoptera.)

It has long been known that a race of this insect inhabits the Butternut and Walnut, which is full one-half longer and wider than the race which infests the Plum. I have met with numerous specimens of both, but never found any intermediate size. Say states, on the authority of Bartram, that this insect also "destroys the European Walnut in this country," but does not notice any difference in the size of the Walnut-inhabiting race. I conceive that the two are Phytophagic Varieties or perhaps Species, differing from each other as do the two races of *Chrysomela scalaris* Lec., which inhabit respectively the basswood and elm or the dogwood and plum. (*Proc.* &c. III. p. 403.)

DORYPHORA 10-LINEATA Say and D. JUNCTA Germ. (Coleoptera.)

I have already, in the "Practical Entomologist" (No. 1), shown that the former of these two very closely allied species inhabits plants belonging to the botanical family Solanaceæ, and especially the genus Solanum; while the latter most probably inhabits the Hickory, or at all events does not feed on Solanum. We may therefore consider the two as Phytophagic species.

Typically there are on the thorax of each of these species eighteen spots, arranged in the same very peculiar pattern, viz: two large, divergent, elongate ones arranged side by side in the middle, and respectively between and behind these a single minute one placed on the dorsal line; while on each side of this four-spotted pattern are seven small spots, five of them on the hinder part of the thorax in a quincunx narrowed in front, and the other two before this quincunx, scarcely wider apart than the two hind spots of the quincunx, and obliquely arranged, so that the outer one of the two is always twice as far from the anterior edge of the thorax as is the inner one. Now eighteen spots may be arranged in a given trapezium in an almost infinite variety

of different patterns. If, then, these two species did not spring from some pre-existing form, but were created originally as distinct species, how does it come about that the same very peculiar pattern is repeated on the thorax of each? What possible necessity in that case could there be, for Nature to plagiarize from herself a merely ornamental design, when millions and millions of other designs might just as well, for anything we can see to the contrary, have been selected? I could as soon believe, with the old geologists, that dead fossil shells had been created in the rocks, on purpose to deceive us into believing that they had once been alive, as that, out of the infinity of possible patterns, a particular one had here been selected and imprinted upon two aboriginally distinct species, with the manifest result of deceiving us into confounding those two species together.

I have said that there are *typically* eighteen spots on the thorax of the above two species. Sometimes, however, six particular spots out of the eighteen are some or all of them absent, the *locus* of the remaining spots being still the same; and it is very remarkable, that in the two species it is the same particular spots that are thus absent, viz: the two minute ones on the dorsal line and the central one of each quincunx, which are often absent, and the spot in each quincunx that abuts on the hind angle of the thorax, which is but seldom absent. According to the mathematical theory of chances, this can scarcely be a merely fortuitous event; for the odds are enormously against any one's happening on the same particular six numbers, twice over, out of eighteen numbers.

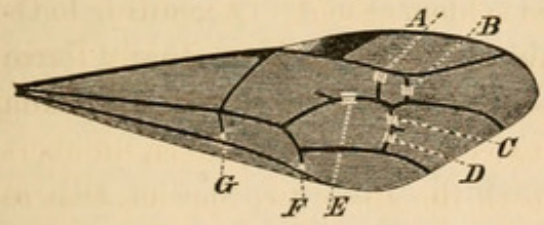
It is sometimes the case also, in both the above two species, that several pairs of the thoracic spots are confluent with each other. Now we have only to imagine all of them confluent, and we get the thoracic ornamentation found in *Chrysomela bigsbyana* Kby, *C. præcelsis* Rogers, *C. elegans* Oliv. and *C. exclamationis* Fabr., viz: a dark-colored thorax bordered laterally and in front with a pale tint; and in *C. scripta* Fabr., *C. interrupta* Fabr., *C. Adonidis* Fabr., and especially in *C. multipunctata* Say, we find intermediate grades between the two forms. Nor is this an entirely imaginary idea as applied to the genus *Chrysomela*. In a series of specimens of one species of this genus, *interrupta* Fabr., as I have already observed, (*Proc.* &c. III. pp. 228–9,) we find, as regards the elytral markings, precisely the same gradations, from sixteen dark spots more or less partially confluent, to a uniform dark color bordered laterally and behind by a pale tint. Nobody doubts that these colorational varieties of the species *interrupta* have all proceeded from a common origin. Why then should we be shocked with the idea, that

the similarly different colorational forms of two such closely allied genera as *Doryphora* and *Chrysomela* have, ages and ages ago, all proceeded from a common origin?

Genus Ichneumon. (Hymenoptera.)

There is another and a still stronger case of what I have called the "Unity of Coloration," which, as it is a very curious one, and does not appear to have been hitherto noticed or elucidated by any author, I may be excused for dilating on. In fact, colorational characters such as these, which prevail throughout several species or throughout whole genera, are usually neglected by those entomologists who occupy themselves in establishing new genera, because the commonly received opinion is that genera must be founded, not upon colorational, but upon structural characters; and by those who occupy themselves in describing new species, because, being found indifferently in many species, they are of little or no value as specific distinctions. Yet the very circumstances, that cause them to be neglected by these two classes of writers, are precisely those which render them of pre-eminent interest to the philosophic naturalist.

The annexed figure represents—magnified about three diameters—the front wing of any species of *Ichneumon* with blackish or fuliginous



wings, e. g. *viola* Cresson, *flavicornis* Cress., *saucius* Cress., *cincticornis* Cress., *scelestus* Cress., *malacus* Say, *morulus* Say, *devinctor* Say, *centrator* Say, *grandis* Brullé, or *rufiventris* Brullé. It will be observed that there are five white spots on it, *A* . . . *E*, which extend beyond the limits of the vein on which they are situated into a blister-like expanse, that has much the appearance of a spot of white mould. Besides these five, there are two minute spots, *F* and *G*, which scarcely ever extend beyond the limits of the vein on which they are located. The *locus* of all these spots is perfectly definite and never differs in any species. *A* is small and often subobsolete, and is invariably located on the internal side of the areolet, and so well forwards as to touch the radial area. *B* is large and obvious, and is invariably located on the external side of the areolet, and almost always slightly behind the middle of the cross-vein which it bestrides. *C* is large and obvious, and is invariably located about midway between the areolet and the obtuse, salient angle of the second recurrent nervure, which angle, as in the figure, often has a short stump of a vein proceeding from it. *D* is small and sometimes subobsolete,

and is invariably located immediately behind this salient angle so as to touch its apex. *E* is large and obvious, and is invariably located about midway between the areolet and the obtuse, re-entering angle of the first recurrent nervure, which angle, like that of the second recurrent nervure, often bears a short stump of a vein, as shown in the figure. And *F* and *G* are minute and inconspicuous, and invariably located on the hind end of the two hindmost cross-veins, so as to touch the anal or postcostal vein.

Although three of these five blister-like spots, viz: *B*, *C* and *E*, are obvious, so far as I can find out, in every N. A. species of *Ichneumon* that has blackish wings, the other two being generally smaller and not so conspicuous, and although Mr. Cresson, on my calling his attention to the subject, kindly informs me that he notices them in many European species with blackish wings, yet they have been almost entirely overlooked by authors. Say refers to them only in his description of *I. malacus*, where he calls them "bullæ," (blisters or bubbles,) and in his description of *I. morulus*, where he calls them "white dots;" Cresson refers to them only in his descriptions of *I. Blakei* and *I. scelestus;* and Brullé does not refer to them at all. As to the minute spots, *F* and *G*, though they occur, not only thoughout the genus *Ichneumon*, but in every specimen of every species of every genus belonging to *Ichneumonidæ*, (and I might add *Braconidæ*,) that I have hitherto examined, yet I cannot find that any author has as yet taken any notice whatever of them.

But these five "bullæ" are not confined to those species of *Ichneumon* that have blackish wings. I discover that, by holding the wing up to the light, they may be detected, more or less plainly, in all the species of *Ichneumon*, at least seventy in number, that are contained in my collection, many of which have almost perfectly hyaline wings.*

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*My collection comprises *viola* Cress. ♀ (=*maurus* Cress.=*Orpheus* Cress.), *flavicornis* Cress. ♂, *malacus* Say ♀, *saucius* Cress. ♀ (=*ater* Cress.), *cincticornis* Cress. ♂ ♀, *morulus* Say ♂ ♀, *vittifrons* Cress. ♂, *scelestus* Cress. ♀, *extrematis* (*-mus?*) Cress. ♂ ♀, *unifasciatorius* Say ♂, *otiosus* Say ♂ ♀, *agnitus* Cress. ♀, *pulcher* Brullé ♂, *cæruleus* Cress. ♀ (=true ♀ of *pulcher?*), *jucundus* Brullé ♀, *Grotei* Cress. ♂, *flavizonatus* Cress. ♂, *atrifrons* Cress. ♀, *comptus* Say ♂, *paratus* Say (1836) ♂, *comes* Cress. ♂ ♀, *devinctor* Say ♀, *fuscifrons?* Cress. ♀, *pectoralis?* Say ♂, *funestus?* Cress. ♀, *centrator* Say ♀, *suturalis* Say ♀, *seminiger* Cress. ♀ (=*vicinus* Cress.), *annulipes?* Cress. ♀ (=*pusillus* Cress.), *grandis* Brullé ♂ ♀ (♂=*ambiguus* Cress., ♀=*regnatrix* Cress.) and *rufiventris* Brullé ♂ ♀ (=*semicoccineus* Cress.=*incertus* Cress.) The remaining thirty-nine species are not described either by Say, Brullé or Cresson, and are probably most of them new. As regards the synonymies given in the above list, it is proper to add here, that I do not find

On the other hand, in other Ichneumonidous genera there exist homologous spots, but often different in number or differing slightly in their location, though they are manifestly modifications of the same primordial pattern. For example in *Trogus*, where the pentagonal areolet of *Ichneumon* becomes rhomboidal by the elimination of the upper side, *A* generally covers the whole angle formed above by the union of the inner and outer sides of the areolet, and the other four bullæ are placed as in *Ichneumon*. In *Pimpla* and *Ephialtes*, which also have a rhomboidal areolet, *A* is placed above *B* on the upper end of the outer side of the areolet, and in *Pimpla* is generally separated from *B* only by a very small space, and sometimes entirely confluent with it, the other three bullæ being located in both genera nearly as in *Ichneumon*, except that *E* is usually closer to the angle of the first recurrent vein. In *Cryptus* there are normally but *four* bullæ, *C* and *D* being confluent and the others placed as in *Ichneumon*, except that *B* is located higher up on the cross-vein which it bestrides. In *Glypta*, where the areolet is represented by a simple cross-vein, *A* and *B* are absent, but as *C* and *D* are not quite confluent, being divided by a slender black line or black dot, there are *three* bullæ, *C*, *D* and *E*. *Odontomerus*, *Xylonomus*, *Acænitus* and *Arotes* differ from *Glypta* chiefly in *C* and *D* being separated by a very wide space, and have the same number of bullæ. And in *Ophion* and *Anomalon*, where the areolet is also represented by a simple cross-vein, *A* and *B* are absent, but *C* and *D* being perfectly confluent, there are consequently but *two* bullæ. So far as I can discover, on a careful examination, there is no Ichneumonidous genus

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either the shape of the "central area" of the metathorax, or the number of joints contained in the antennal annulus, a constant and reliable specific character. In very many well-marked species of which I possess numerous specimens, the width of the "central area," as compared with its length, varies 50 per cent. with all the intermediate grades, i. e. varies from "transverse" to "quadrate" or from "quadrate" to "elongate;" and in other such species the length of the antennal annulus varies very considerably, often by three or four and in one species by as much as seven joints, with numerous intermediate grades. It is even the case that in one undescribed species, allied to *parvus* Cresson, of which I possess seven ♂, a single ♂ has two or three of the intermediate antennal joints marked with yellowish-white above, while the remaining six ♂ have no such markings whatever. And Westwood records the fact that "two ♀ of *Cryptus bellosus* were reared by Mr. Thwaites, one of which had the antennæ annulated and the other entirely black." (*Intr.* II. p. 138, note.) If all specimens that differed in the above characters were considered as distinct species, the number of species in my collection would be very largely increased, and my argument strengthened so much the more.

that has not some such modification of that type of bullæ which prevails in *Ichneumon*, and none that has not at least two bullæ, viz: *C* (or *CD*) and *E*.*

Although, as I believe, the bullæ exist typically in every species of *Ichneumon* in the pattern peculiar to that genus, yet, as we might naturally expect, we occasionally in certain species meet with certain specimens, where they are partially obsolete, or undergo some other slight modification, sometimes in one wing only, sometimes in both wings of the same specimen. In order to test this question, I have carefully examined both front wings in 319 specimens belonging to the 70 species of *Ichneumon* which I possess, making in all 638 wings. Of these 638 wings as many as 75, belonging to 28 different species, have the bulla *A* obsolete; 28 wings, belonging to 15 different species, have the bulla *D* obsolete; † in one wing only of the 638, belonging to a single ♀ of *seminiger* Cress. out of 3 ♀ which I possess, is the bulla *C* obsolete; but in none whatever of the 638 are either the bulla *B* or the bulla *E* obsolete. In 5 wings out of the 638, belonging to 3 different species, where the areolet is subrhomboidal, including 1 ♂ out of 28 ♂ of *flavizonatus* Cress., the bullæ *A* and *B* are confluent above. And only in 2 wings out of the 638, viz: in 2 ♂ of *morulus* Say—a very abnormal species with metathoracic thorns ‡—out of 3 ♂ 2 ♀, is there a small additional or spurious bulla located on the side of the areolet that adjoins the discoidal cell, but only on the inside of the areolet and not extending on to the vein. In 11 out of 13 specimens of *Trogus obsidianator* Brullé which I possess, this same additional spurious bulla or rather semi-bulla makes its appearance. But neither in the three other

*Say describes the "bullæ" by that name in *Anomalon attractus*, *An.* (*Odontomerus*) *mellipes*, *Ophion brachiator* and *Cryptus grallator*; and describes them as "white spots" in *Banchus æquatus* and *B. nervulus*. Of course, if he had been aware that these bullæ are, properly speaking, a generic character common to all the species of the same genus, he would not have given them as characters of particular species. Brullé neither names nor describes the bullæ in any of his descriptions of *Ichneumonidæ*, though his Artist has figured them *Plate* XLII, fig. 1. And Mr. Cresson tells me that "neither Fabricius nor Gravenhorst, so far as he can see, mentions the bullæ or any other term for that character."

† In several small species with hyaline wings, which I have referred to this category, the second recurrent vein is so nearly straight, that it is difficult to say, whether it is the bulla *D* that is obsolete or the bullæ *C* and *D* that are confluent.

‡ If *Hoplismenus* Grv. can be retained as distinct from *Cryptus*, which Brullé denies, then this species should also be erected into a genus distinct from *Ichneumon*.

species of *Trogus* in my collection, including *T. exesorius* Brullé, nor in any other Ichneumonidous species, so far as I have observed, except *Cryptus robustus* Cress. six ♀, and an apparently undescribed species (one ♂ one ♀) belonging to a new genus intermediate between *Joppa* and *Baryceros*, do I find any traces of this remarkable anomaly. The above is the sum total of variation, as regards these "bullæ," in 638 wings appertaining to 70 distinct species of *Ichneumon;* and it appears to be almost universally variation and not specific difference, because there is but a single instance where a species, represented by over two specimens, exhibits any given variation in both the front wings of all the specimens. That instance is *annulipes*? Cress., a very variable species, of which I possess eight specimens, no two of them exactly alike in their general coloration, and all eight of which have the bulla *A* obsolete in both wings. In 319 specimens of any given species of insect, we should be apt to find almost as great an amount of variation, as that which has been detailed above, in any given specific colorational character. And yet this particular type of bullæ is not a specific character, but one which runs through 70 distinct species of a particular genus; and as already stated, remarkable modifications of the normal bullæ of *Ichneumon* are found in all the other Ichneumonidous genera with which I am acquainted.

Besides the seven spots which, as has been already shown, exist typically in the front wing of *Ichneumonidæ*, there are usually in the hind wing two bullæ located on the lower or hindmost end of the two principal cross-veins. But for the purpose which I have in view, it is unnecessary to dwell upon this point.

I might have insisted likewise on the very general, though not universal, persistence of the pale spot at the base of the stigma throughout *Ichneumonidæ* and *Braconidæ*, and several other Hymenopterous families; and, indeed, throughout certain families belonging to other Orders. But as this character is perhaps partly structural, being connected with the thinner organization of the stigma at that particular point, for certain unknown structural or functional purposes, I have forborne taking any account of it. In the case of the bullæ, however, we cannot reasonably assume, that any structural or functional necessity could require a wing-vein to become suddenly thinner at some particular point, and then as suddenly become as thick as before; for it has been proved that the wing-veins are, properly speaking, veins, *i. e.* that they are fluid-conducting tubes. And even if we make some such gratuitous assumption, this will not explain the white blotch on the membrane of

the wing, which almost always in the bullæ *A* . . . *E*, but scarcely ever in the spots *F* and *G*, adjoins the white spot on the vein itself.*

To entomologists who have worked much on any particular group or groups of insects, the facts stated above will, I suspect, seem not at all extraordinary. For many similar cases of Colorational Unity occur in every Order; and it has repeatedly happened to myself, and I doubt not to others, that, after having examined numerous species belonging to a given genus, I come at last upon one with a particular spot or a particular stripe conspicuously developed in a particular *locus*, and, on recurring to the species already examined, find more or less faint traces of the same spot or the same stripe in every one of them. But to the student in other departments of Natural History, where the number of species is so very much smaller than in Insects, and where consequently there is no such opportunity to form very extensive generalizations, the phenomena detailed above will appear, perhaps astonishing, perhaps incredible, perhaps false. They are nevertheless strictly true; and any one may easily satisfy himself of their truth, by selecting at random any species of *Ichneumon* and holding up its wings to the light under a moderately good lens.

The question naturally occurs here to the philosophic mind—What is the MEANING of all these facts? Why do the same bullæ in the same *loci* occur in so many distinct species of the same genus? Why do not some species have these bullæ located on some of their other veins, or on some other part of the same vein? Why, for example, is there never a bulla on the *basal* side of the angle of the first recurrent vein, either in *Ichneumon* or in any other Ichneumonidous genus? Why are there not sometimes six or eight or ten bullæ? Why are there not sometimes none at all? In every species of *Ichneumon* we find, it is true, without exception, a pentagonal or subpentagonal areolet and a very short ovipositor. But the reason of this is obvious. If the insect was without these characters, it would not be placed in the genus *Ichneumon*, because these are some of the established generic characters of *Ichneumon*. Yet so far is it from being the case, that the bullæ are an established generic character of *Ichneumon*, that they do not appear to have been even noticed hitherto, except incidentally in the descriptions of a few species. Look at the figure given above. Any one can see that the seven white spots on it might be arranged on the wing in millions and millions of different patterns. Why then in

* I observe that in *Thyreodon* and *Ophion* the spots *F* and *G* often extend on to the membrane of the wing, precisely as in bullæ *A* . . . . *E*.

seventy distinct species of the same genus are they always arranged in the same pattern, subject only to the very slight variations noticed above? Why—as is most likely the case—should Nature have servilely repeated the same monotonous Colorational Pattern throughout the whole genus *Ichneumon*, which probably comprises at least 500 species, and is numerously represented on both sides the Atlantic? Why in allied genera do we find curious modifications of the same fundamental pattern, and not entirely new and original patterns? Why in allied genera do we find none entirely without bullæ, and none without the spots *F* and *G*? Why is the *locus* of the spots *F* and *G* absolutely invariable throughout *Ichneumonidæ* and *Braconidæ*? If these seven spots could answer any possible utilitarian purpose, we might say that they occur throughout *Ichneumon*, because the peculiar habits of that genus require them for that purpose. But they are manifestly mere ornamental designs, in no possible respect necessary or useful to the individual *Ichneumon*, any more than the numerous small, pale spots on the bodies of many adult Fallow Deer, which occur also in the fawn of the common North American Deer, are necessary or useful to the individual Deer.

To my mind, there can be but one satisfactory answer to all the above questions. There MUST be a close genetic connection between all the species of the genus *Ichneumon*, and a more remote genetic connection between that genus and the other genera of *Ichneumonidæ*. "Community of descent," says Darwin as interpreted by Lyell, "is the hidden bond which naturalists have been unconsciously seeking, while they often imagined that they were looking for some unknown Plan of Creation." (*Antiq. Man.* p. 412, Amer. ed.) Let him, who refuses to accept this solution of the enigma, offer a better solution himself.

——— Siquid novisti rectius istis,
Candidus imperti; si non, his utere mecum.

But do not let him utter sonorous common-places, about carrying out the Plan of Creation and completing the System of Nature, and then fancy that he has explained facts, when in reality he has only re-stated them in general terms.

Rock Island, Illinois, Nov. 15, 1865.