eggs are deposited singly by the female upon the leaves of the tree which she selects for this purpose. No case is on record of the larvæ ever swarming in such numbers, as to do any material amount of damage to the foliage of any tree; but we regret to say that those of another noble moth which is closely allied to it, and which is a still more general feeder, the Cecropia moth (*Attacus cecropia*) sometimes inflict considerable injury upon apple-trees, and, according to Mr. Perkins, of Onarga, Ill., upon one occasion stripped his young tulip-trees (*Liriodendron tulipifera*), erroneously called "poplars" in many parts of the West, completely bare of their leaves.

The antennæ of the Polyphemus Moth are feathered in both sexes, but much more widely in the males than in the females. Our figure represents the male sex; and as will be seen at once, the antennæ might in this sex be readily mistaken by an inexperienced person for a pair of little bastard wings growing out of the head. In that excellent new French periodical, *Le Naturaliste Canadien*, (p. 22) will be found an amusing account from the pen of the Editor, of such a mistake having been actually made by a certain Canuck. We cannot resist the temptation of translating here the whole story from the original French, for the benefit of the American reader.

We must *look* in order to *see*; and in Natural History perhaps, more than in any other department of knowledge, we must know *how* to look, in order not to be deceived in our observations. One day one of our worthy neighbours came to call upon us with a very self-satisfied air. "Oh, Sir," says he, "I can show you—you who are so fond of rare things—an insect such as you have certainly never seen." "Take care: my collection is pretty large." "I have seen your collection, and you have nothing like it. It is a butterfly with six wings!" "A butterfly with six wings?" "Yes, sir, with six wings. Besides the four wings in the ordinary places, it has two little ones in addition on its head. It has a body as stout as that of a middling-sized mouse, and two large eyes in its hind wings. All those to whom I have shown it say they have never seen anything like it. But what is most extraordinary about it is these little wings on its head. What can be the use of them?" Recognizing without trouble by means of this description the insect that was referred to, we replied, "You know that butterflies are travelers, or rather navigators, in the air. Ordinarily they have only four wings, which, if you please, we may liken to the mainsails and topsails of our common sloops or cutters. Probably your butterfly, having a longer voyage than usual to make, has found it advantageous to add a foresail; and I should not be at all surprised if some other one took it into his head, some fine day to hoist a jib ahead of his other sails, so as to be still more complete. But in the mean time let us go and see how yours is rigged out." Our friend, who had received our raillery with a self-satisfied air, because he believed that he should soon have his revenge, by the stupefaction into which we should be thrown by the sight of his wonderful phenomenon, was quite put out of countenance when, at the first glance that we threw upon his insect, we recognized the male of our Polyphemus Moth, and invited him to come and see five or six others just like it in our collection. He had mistaken for wings the feathered antennæ of that magnificent moth, which are especially well developed in the male sex, and which he had not taken the trouble to remark in the specimens in our cabinet. But far from wishing to turn aside our young naturalist from his observations, in consequence of this unfortunate result of his first attempt, we made him faithfully promise to examine well all these little beings which are every day presenting themselves before our eyes; assuring him that, although he would never find insects with wings on their heads, he would nevertheless find other wonderful things that would interest him still more.

We repeat the same advice to all our readers. Look! observe! examine! and you will see wonders without number unfold themselves before your eyes.

It may be perhaps worth while to add, that the males of a genus of Span-worm or Measuring-worm Moths, found in Europe but not hitherto discovered in America (*Lobophora*), are remarkable for their hind wings being furnished with a small membranous lobe, which gives them the appearance of possessing an additional pair of wings; and that, among the Feather-winged Moths (*Alucita* family), each wing is split more or less deeply into from two to six feathered rays, so as almost to deceive one into believing, that they really have about ten or twelve wings, instead of only four. Of this last group, one species (*Pterophorus periscelidactylus*, Fitch) is quite common upon grape vines, on the leaves of which the leaf-rolling larva feeds exclusively, but seldom in such numbers as to do any material amount of damage.

WASPS AND THEIR HABITS.

There are, at least, five hundred different kinds, or species, of wasps found within the limits of the United States, of the natural history of which, inasmuch as it is both interesting and instructive, we now propose to give a brief sketch. Much as some of these insects resemble one another at first sight, yet their structure and their habits are often very different; but, according to the general rule, wherever their structure is the same, it will be found that their habits are nearly, or quite the same. So that, in order to know what are the general habits of a species that we may come across, it is not usually necessary to find out the name of that particular species, but only to ascertain to what particular group it belongs. For, as with other animals, species belonging to the same group have the same, or nearly the same, habits.

In common with all kinds of bees and ants that have any sting at all, it is only the females among the wasps that have stings, the males possessing no apparatus of the kind. Almost everybody, for example, knows that the drone of the honey-bee may be handled with perfect impunity; and the drone is nothing but the male of the honey-bee, as all bee-keepers are well aware. Just so, all male wasps may be

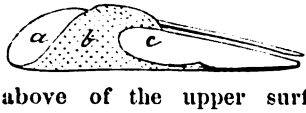
handled without fear; but, unfortunately, in order to distinguish the sex, we are generally obliged to catch the little animal first; for, as a general rule, which, however, admits of exceptions, the male wasp is scarcely distinguishable from the female, except by having, with a very few exceptions, thirteen-jointed (not twelve-jointed) antennæ, and a seven-jointed (not six-jointed) abdomen. So that, practically, this criterion is not of much value; and to ascertain whether a wasp can sting, we must first take it in our hands, and give it a fair chance to do so if it is able. It is remarkable that the very same distinctions between the sexes, as those which have been detailed above as generally found among the wasps, prevail almost universally among the ants and bees.

The Digger Wasps and the True Wasps.

The wasps are divisible into two grand groups, the first of which is two or three times as numerous in species as the second; namely, *first*, the Digger Wasps, or Fossorial Wasps (*Fossores*), and *secondly*, the True Wasps, or wasps with folded wings (*Diplopteryga.*) There is no one obvious universal character by which, without a solitary exception, these two groups are distinguishable; but, with the exceptions hereafter to be noted, they may be distinguished by the following easily-observed criterions:

1. None of the Digger Wasps have their wings folded up in repose. All the True Wasps, on the contrary—with the single exception of an exotic genus (*Ceramius*), which has not as yet been found in North America, and to a partial extent, of another exotic genus (*Masaris*), found in this country exclusively in the Rocky Mountain region—have their wings folded in repose, in the singular manner shown in Figure 96, where *c* represents the upper surface of the hind wing, with its front edge hooked on as usual to the hind edge of the front wing; *a*, all that is visible from above of the upper surface of the front wing, and *b*, the lower surface of the front wing doubled over upon itself. Westwood has remarked that this peculiar folding of the wings "is so constant and characteristic, that we look in vain throughout the whole order (*Hymenoptera*) for any other instance." But, Westwood forgot that, in a single genus of *Chalcis* Flies (*Leucospis*), the wings are folded in precisely the same manner, as had been partly stated by himself in a previous page of the same volume.* With this exception, his remark appears to be correct.

[Fig. 96.]



2. The eyes of the Digger Wasps are generally oval, rarely round, as in the female of one genus (*Mutilla*), or kidney-shaped, as in both sexes of two genera (*Trypoxylon* and *Scolia*), and in the males, but not in the females, of two other genera (*Mutilla* and *Myzine*). On the contrary, all the True Wasps, with the single exception of one Australian genus (*Paragia*), have their eyes kidney-shaped, the hollow, or scooped-out part of the kidney facing the base of the antenna.

3. Most of the Digger Wasps, especially in the female sex, have their legs thickly set with long stiff bristles or slender thorns, the use of which we shall presently see. Certain exceptions which occur will be noticed hereafter, and the reason thereof explained. The True Wasps, on the other hand, always have their legs free from bristles or thorns, although the joints of their paws (*tarsi*) are often prolonged on each side in an acute angle at their tips, so as at first sight to somewhat resemble small thorns.

Having thus enabled the reader to tell the difference between a Digger Wasp and a True Wasp, we will take up each group in its turn and explain and illustrate its peculiar habits.

The Digger Wasps.

Every one knows that Blow-flies or Meat-flies will deposit their eggs, which are commonly called "fly-blows," upon meat; and that these eggs soon afterwards hatch out into whitish meat-feeding maggots, destined in the course of a few weeks to reproduce the mother-fly; after which the same old cycle of phenomena is repeated again and again. In the same manner, the thousands of different species of Moths and Butterflies, the larvæ of which feed upon the leaves or the buds or the stems of different herbs, shrubs and trees, deposit their eggs in or on, or at all events close to, the substance upon which their future larvæ are destined to subsist. And to these might be added a host of other insects, such as the various Clothes-moths and Fur-moths, the Cheese-fly, the different Bacon-beetles and Cheese-beetles, the Apple-worm Moth, &c., &c., all of which have the same remarkable habits in this respect. We call them remarkable, because many of these insects can not feed in the perfect state—in which state alone they are capable of laying eggs—upon the substances that they lay their eggs on. For instance, all the Butterflies and Moths feed in the perfect state upon the nectar of flowers or other

*see Westwood's *Introduction*, II, p. 238, and p. 164.

such liquid matter, if they take any food at all; while most of their larvæ feed upon the tissues of various plants, a few upon woolen clothes, a a few upon furs, and a few even upon fatty substances. Yet nobody ever found one of these Butterflies or Moths depositing its eggs upon the nectary of flowers, where the honey which they themselves love so dearly is to be found; but, on the contrary, they each of them uniformly lay their eggs upon that particular substance which they are instinctively aware that their future larvæ will relish, but for which they themselves have no taste whatever.

Certain dung-feeding beetles—for example, a species (*Ligyrus relictus*, Say), which is often mistaken both in the larva and in the perfect state for the common May-bug or May-beetle (*Lachnosterna quercina*, Knoch)—follow the same wonderful plan which has been detailed above; that is, they deposit their eggs in any mass of dung that they can find. But far more commonly among those beetles, the larvæ of which feed upon dung, we find an improvement upon the usual system. Instead of depositing their eggs in the dung, wherever it lies, they bore deep holes in the ground underneath it, and carry down little pellets of it into these holes, in which pellets they lay their eggs; thus securing the savory morsels from the various other insects that adopt the more primitive custom referred to above. On precisely the same principle the Burying-beetles (*Necrophorus*) lay their eggs in small pieces of carrion, such as dead rats, dead birds, &c., having previously buried the carrion completely underground to prevent Meat-flies from "fly-blowing" it, and having by this means effectually monopolized it for their future offspring. On one particular occasion, having deposited a full-grown dead rat upon newly-moved earth in a particular spot, as a trap for these Burying-beetles, we found that in twelve hours' time the carcass had been completely buried, all but the tip of the tail, by a single individual of our largest and handsomest species (*N. americanus*, Oliv.), a beetle which is only 1½ inch long. It would puzzle an Irish laborer to bury a full-grown whale in the same length of time; yet proportionally this would be a task of precisely the same magnitude.

In the case of the Burying-beetles and certain Dung-beetles, we caught the first inkling of an improvement upon the usual habits of insect life; for these, as we have seen, bury the substance upon which their future families are destined to subsist, a few inches under ground. In the case of the common Tumble-dung Beetles (*Canthon*), we find a still further development of useful and intelligent industry; for these, as every American must have noticed, not satisfied with burying the pellets of dung, destined each of them to feed to maturity the larva of a future Tumble-dung, on the spot where that dung has been dropped—as, for example, is the universal practice of an allied genus (*Geotrypes*) of about the same size and shape—roll them over and over for several yards, till they have reached a snug retired spot, and then, and not till then, proceed to bury them. Authors have been much puzzled to account for this extraordinary proceeding; but, to our mind, the reason of it is obvious. There are a great number of rather small Cannibal Ground-beetles (*Carabus* family), the larvæ of which prey upon the larvæ of such dung-feeding beetles as bury the dung on the spot where it falls, the mother-beetles being directed to the spot, so as to know exactly where to lay their eggs, by the presence of the unsavory substance itself. By removing the precious pellet to a suitable distance and then carefully burying it, the provident Tumble-dung guards against such a mishap; though, even with such careful forethought, she does not in all probability entirely elude the attacks of other insect foes.

In confirmation of the above theory as to the habits of the Tumble-dung, it may be observed that, although we have in Illinois at least four distinct species of the dung-burying genus (*Geotrypes*) just now referred to as closely allied to the Tumble-dung, and only one species of Tumble-dung (*Canthon lævis*, Drury) known to have the remarkable habits referred to above, * yet the latter are at least 100 times as numerous in individuals as the former. Why should this be so? These beetles are nearly all of the same size, shape and strength. They all breed in pellets of dung buried pretty deeply in the earth by the parent-beetle. The only difference in the habits of the two genera is, that the first buries its dung on the spot where that dung is dropped, and its larvæ are consequently more easily detected by their insect foes; while, taught by a wise Providence, the more careful Tumble-dung removes its odorous pellets to a safe distance from the dangerous spot, and thus escapes with comparative immunity from the attacks of its Cannibal enemies. Consequently the Tumble-dungs beat their less skillful antagonists in the struggle for existence, and out-breed and outnumber them, just as the Caucasian White man out-breeds and outnumbers the uncivilized Red

* A single specimen of *Canthon viridis*, Beauv., has been found near Rock Island by the Senior Editor; but the habits of this minute species are not known.

Indian in the great ever-recurring struggle for superiority on the Continent of America.

This curious propensity to roll balls of dung to a considerable distance was observed, thousands of years ago, with mysterious awe by the ancient Egyptians and by the ancient Greeks, and all sorts of superstitious and transcendental notions were founded thereupon. But up to the present day, no one has satisfactorily explained the phenomenon. Verily, under every stone, under every clod, and even under such despised substances as it almost offends the fastidious ear to name, there lies a whole volume of Natural History written by the finger of the great Common Father of us all.

It is always in the order *Hymenoptera* (Bees, Wasps, Ants, Ichneumon-flies, &c.), that we must look for the most exalted and widely spread developments of the instinct of insects. Among the Beetles (order *Coleoptera*) we find but a single genus, the Tumble-dungs, that remove the food of their future larvæ to a considerable distance from its natural locality; and this, too, they effect with their legs, and not with their wings. Yet they have fully developed wings, and, on a hot summer's day, fly with the greatest vigor; and by sub-dividing the dung-pellet into small portions, and carrying them one after another through the air to a suitable spot, they could effect in five minutes as much work as they now effect in five hours. Among the *Hymenoptera*, on the other hand, we find whole hosts of groups, namely our friends the Digger-Wasps, that do every day what, with all his wonderful intelligence, the Tumble-dung or "Sacred Beetle" of the Egyptians, has never yet been able to accomplish. Taught by the mysterious promptings of nature, the female Digger Wasps first of all fly round diligently till they have found a suitable spot, and then having found it proceed to construct a nest for that future offspring of theirs which they are destined never to behold; some of them for this purpose boring holes in timber, some excavating the stem of a dead weed, but the greater portion of them forming holes in the level ground or in clayey banks. The house is now built. It remains to furnish it with food, as well as lodging for the young larva that is soon to come into the world. For this purpose the wings of the female are again called into requisition; for we are almost ashamed to say that in the case of these Digger Wasps, as with nearly all other insects, it is the female only that works, the male being an idle gentleman who occupies his time entirely with sipping honey and pollen and gallanting the ladies. Flying forth among the trees and bushes, and eagerly scanning the hidden recesses of the most tangled herbage, the female Digger Wasp soon discovers a specimen of the particular kind or kinds of insect or spider, which it is the habit of the species to which she belongs to select. Seizing it and pricking it with her sting just sufficiently to paralyze it for ever, but not so as to deprive it of life, she then flies off with it in triumph to the already constructed nest, and returns for additional specimens, till she has accumulated a sufficient supply of meat to feed one of her own larvæ to maturity. She next deposits a single egg among the still living but paralyzed animals that she has collected, seals up the mouth of her nest or cell, usually with earth or tempered clay or fragments of wood, and is off once more to build and provision new nests and repeat the same process over and over again, until her stock of eggs is exhausted. The larvæ that afterwards hatch out from these eggs are in every case soft legless whitish maggots, with a somewhat horny head and a strong pair of jaws, but no other weapons whatever, whether offensive or defensive. Yet, strange to relate, they live at their ease among the prey collected for them by maternal forethought; and this prey is often a lot of bees that, if in full vigor, would sting them to death in a moment, or a mass of ravenous spiders that, but for the fatal poison infused into their vitals, would like no better sport than to gobble them up at a single mouthful.

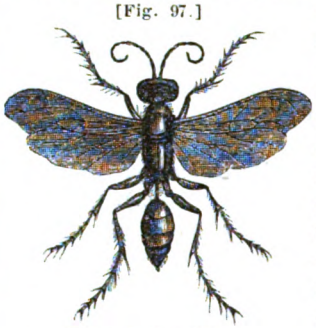
"But," it will be asked, "why this unnecessary cruelty? Why not at once sting the poor bees or caterpillars or spiders to death, and put them out of their misery?" The answer is, that the larvæ of these Digger Wasps live several weeks before they are full-fed and ready to form their cocoons; that during all this period they require fresh meat; that the time of the year when these operations take place is during the heats of the summer; and that, throughout that season, insects or spiders that were stung to death would putrify and become unfit for food in a single week. There are seldom any mistakes in Nature. The Power that created the Digger Wasp knew what kind of food its larva required; and—whether by direct or indirect means it matters not—He has so organized the mother-insect, that she is enabled and impelled to provide for her offspring the right kind of food, in the right quantity, at the right time, and in the right place. With a vast apparatus of steam-boilers and hermetically sealed cans, man has at length succeeded in preserving meat, fresh and untainted, for an indefinite time. With nothing but her good sharp sting and her

little bag of poison attached to it, the female Digger Wasp, even since the creation of the world, has been doing the very same thing in its own department of life. Yet, because the animal is comparatively a small one, we overlook and despise the beauty and simplicity of the process by which it works. In reality, however, this process is just as wonderfully ingenious, as if a ship-owner had the power of provisioning his ship with living sheep and living oxen, manipulated in such a manner that they could be packed in the ship's hold like so many hogsheads; that they should require no food or attendance there, and neither kick nor struggle nor bellow nor bleat, but lie perfectly still; and yet that, whenever wanted for food, they could be hauled up out of the ship's hold and converted at pleasure into good fresh juicy beef and mutton.

In some cases, a single caterpillar, or spider, forms sufficient food for a single larva; and then the nest is provisioned with only a single individual. Sometimes, when such an animal is too large and heavy to be transported through the air, certain Digger Wasps (genera *Ammophila*, *Sphex*, and *Pompilus*) have been observed to drag it along the surface of the earth, after the manner in which the tumble-dungs work; but this is the exception, and not the rule. In other cases, as with several species of Wood Wasps (*Crabro* family), that bore nests for themselves in timber, and provision them with plant-lice; nearly a hundred individuals are stored up for a single larva. The more usual number is from half a dozen to a dozen. In no known case does any Digger Wasp attempt to rear more than a single larva in a single nest. As already hinted, each species of Digger Wasp usually selects a particular species, or, at all events a particular group, either of insects, or of spiders, as food for its young; but there are several exceptions to this rule, owing, do doubt, in part, to the occasional inability of the mother insects to procure the appropriate kind of food in sufficient quantities.

With the single exception of one small order (*Neuroptera*), no order of insects is exempt from the attacks of these all-devouring wasps. Some provision their nests with grasshoppers, some with cockroaches, some with snout-beetles of various kinds, some with ants, bees, and in Europe even with honey-bees; a few with different kinds of bugs, frog-spittle insects, and plant-lice; a great number of them with various kinds of two-winged flies, and a still greater number, perhaps, with the larvæ of various moths; and, besides all these, many distinct species, belonging to widely distinct genera, prey upon spiders. St. Fargeau, however, has correctly remarked, that in no known case, does any Digger Wasp provision its nest with other Digger Wasps, either belonging to its own species, or to any other species.* The habits of comparatively but few North American species have been hitherto observed; but it was long ago recorded by Catesby that a common Blue Digger Wasp (*Chlorion cæruleum*, Drury, Fig. 97), makes its nest in the earth, and provisions it with a spider greatly larger than itself;† and we have ourselves observed a very common Digger Wasp (*Bembex fasciata*, Fabr.), a figure of which will be found below, burrowing in a sandy spot of ground, and provisioning the nests which it has thus constructed, with the common shining, green blow-fly (*Musca Cæsar*, Linn). We have observed, too, on passing over sandy plains frequented by these last insects, that they will often fly round and round one's person in rather an alarming manner, though we have never known them to sting under such circumstances. Their object, no doubt, is to distract the attention of the intruder, and prevent him from noticing or disturbing their nests. St. Fargeau observed similar facts with regard to a European species (*B. rostrata*)—which, like our common species, provisions its nest with two-winged flies—and states that, as soon as he set himself down a little way off, and remained perfectly still, the insects took no further notice of him.‡ It is a good illustration of what has been called the *Unity of Habits* in insects, that all the species of this genus, the habits of which are known, whether in Europe, or in America, provision their nests with two-winged flies (*Diptera*), and exclusively with such as belong to the Second Grand Division (*Brachycera*) of the order.

[Fig. 97.]



Color—Indigo blue.

[Fig. 98.]

Colors—Black brown and pale greenish-white.

The rapidity with which the Digger Wasps

*St. Fargeau, *Hymenopt*, II, p. 548.

†*History of Carolina*, Vol. II., page 105, quoted by Westwood, Introduction, II, p. 207. Respecting the nomenclature of this insect, see the Appendix at the end of this article.

‡St. Fargeau, *Hymenopteres*, II, p 560

dig their holes is very remarkable, and they disappear under ground in a very short time. Audubon has commented with wonder upon the fact, that our American badger can bury himself in the earth in one minute;* but we once saw the female of one of our commonest Digger Wasps (*Myzine 6-cincta*, Fabr.) bury herself in about half a minute in the sandy loam of a wagon-road.

In illustration of the habits of the same Blue Digger Wasp, which was referred to a few lines above, we will now quote a very graphic account, furnished to us by Mr. George W. Smith, of Grand Rapids, Michigan, of the mode in which this insect effaces all traces of the hole or nest which it has just provisioned. Unfortunately, Mr. Smith was prevented from seeing the Wasp actually carrying the doomed spider underground; but, judging from analogy, the nest had been dug beforehand, and the spider was carried in, the egg laid, and the entrance to the nest effectually closed up during his brief absence. On such a subject as this, we prefer, whenever possible, quoting the evidence of non-professional observers to stating facts observed by ourselves; because, in the latter case, it might be supposed by some that we were palming off "travelers' tales" upon the reader.

On the afternoon of the 23d of last June, while carrying a pail of water to my pony, and passing by a small sand-heap covered with weeds, I saw a wasp of a blue color and the size of a hornet, with a spider as large as itself in its mouth, alight on one of the weeds and from that to the ground. I watered my pony and hurried back, in time to see the curious antics performed by the wasp.

I saw it scraping away a small pile of dirt, which appeared to be sand newly dug up. It scraped with its front pair of feet and then pushed the dirt it had scraped with them further on with its other pairs of feet. Then it commenced patting this dirt with its abdomen, in the same manner as we would ram a newly-set post. It would scrape a little and pound again, and then throw on more dirt. It pounded quite forcibly and very fast. It kept up these actions until the spot was quite like all the rest of the ground. It then flew away to a pear-tree and cleaned itself.

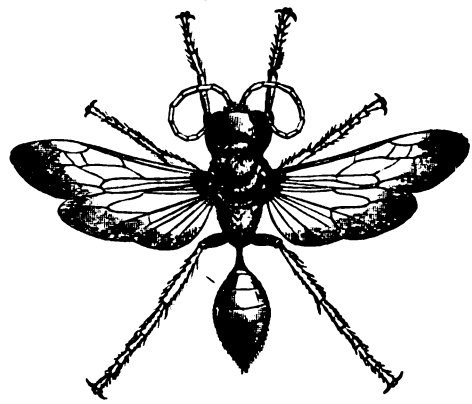
When the wasp was gone, I opened the place where it had pounded so much, and in a hole about an inch deep I found the spider, and under it a small white speck, which I suppose was an egg. The spider did not appear to be entirely dead.

There is another and a much handsomer species of an allied genus of Wasps, the Ichneumon-like Digger Wasp, (*Sphex ichneumonea*, Linn.), of which we herewith present a drawing, at Figure 99.

Unlike the Blue Digger Wasp, which is rather a southern than a northern species, it is common everywhere in the northern States, but instead of lighting chiefly upon the ground, as does its indigo-blue compeer, it occurs more frequently upon flowers. Dr. Packard, in his *Guide to*

*Audubon and Bachman, *History of Quadrupeds*, I, p. 365.

[Fig. 99.]



Colors—Rust-red, with dense golden pubescence.

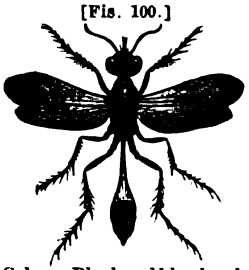
the Study of Insects, (pp. 167—8), has published the following very interesting and original observations on the habits of this species, which with his permission we reprint:

In the last week of July, and during August and early in September, we noticed nearly a dozen of these wasps busily engaged in digging their holes in a gravely walk. In previous seasons they were more numerous, burrowing into grassy banks near the walk. The holes were four to six inches deep. In beginning the hole the wasp dragged away with its teeth a stone one-half as large as itself to a distance of eight inches from the hole, while it pushed away others with its head. In beginning its burrow it used its large and powerful jaws almost entirely, digging in to the depth of an inch in five minutes, completing its hole in about half an hour. After having inserted its head into the hole, where it loosened the earth with its jaws and threw it out of the hole with its jaws and fore legs, it would retreat backwards and push the dirt still farther back from the mouth of the cell with its hind legs. In cases where the farther progress of the work was stopped by a stone too large for the wasp to remove or dig around, it would abandon it and begin a new hole. Just as soon as it reached the required depth the wasp flew a few feet to an adjoining bank, and falling upon an *Orchelimum vulgare* or *O. gracile*, [two common grass-green catydid-like grasshoppers, about an inch long,] stung and paralyzed it instantly, bore it to its nest, and was out of sight in a moment, and while in the bottom of its hole must have deposited its egg in its victim. Re-appearing it began to draw the sand back into the hole, scratching it in quite briskly by means of its spiny fore tarsi, while standing on its two hind pairs of legs. It thus threw in half an inch of dirt upon the grasshopper and then flew off. In this way one *Sphex* will make two or three such holes in one afternoon. The walk was hard and composed of a coarse sea-gravel, and the rapidity with which the wasp worked her way in with tooth and nail was marvelous.

There is another genus of Digger Wasps (*Ammophila*), closely allied to the preceding, but distinguishable at once from it by the abdomen being much slenderer and attached by a much longer stem or peduncle. Of this genus there are about forty different species found in North America, some of which resemble each other so closely that it is not always easy to tell one from another. All those that are known to us are peculiarly fond of alighting upon flowers, where on a hot summer's day dozens of them may often be observed in copulation, the amorous males firmly embracing the females round

their necks, with their long sickle-shaped jaws. The females may generally be handled with the naked fingers with perfect impunity; for, like those of most of the Wood Wasps (*Crabro* family), it is not one time in five hundred that they will use their stings, though they will generally make ineffectual attempts to wound with their long slender sharp-pointed jaws. The species sketched herewith, the Painted-wing Digger Wasp, (*Ammophila pictipennis*, n. sp. Fig. 100), is new to science, and a full description of it will be found in the Appendix. It is tolerably common in South Illinois, but we have never captured it in the more northerly parts of the State, and do not believe that it is to be met with there. Some of our common species greatly exceed it in size and beauty, many of them being elegantly marked in various patterns with patches of silvery white pubescence. All of them, however, have the same general shape and make, and no doubt have the same general habits. We figure this species here, though it is comparatively small and inconspicuously colored, because we have received the following very interesting account of its habits from the mouth of Mr. T. A. E. Holcomb, of South Pass, in South Illinois.

[Fig. 100.]



Colors—Black and blood-red; wings rust-red and dusky.

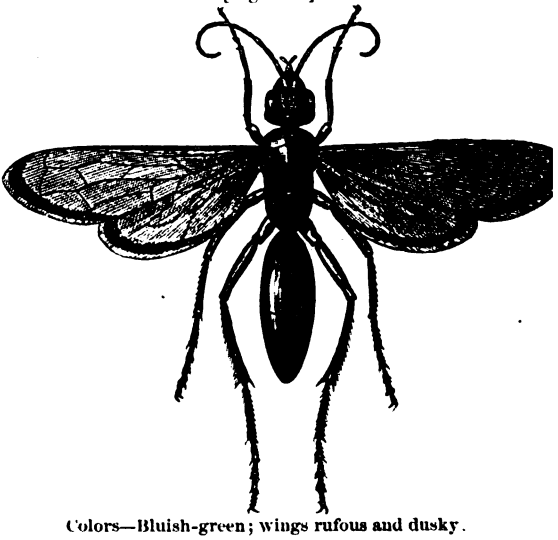
On June 10th, 1868, I saw this wasp carrying a good-sized cutworm along the surface of the ground for a distance of about six rods. She held the cutworm back downwards, so that the head and tail curled upwards, grasping it with her jaws and front legs and walking with her four hind legs. I watched her for a long time, and began to think she would never arrive at the end of her journey; but at last she commenced circling about with the worm till she found the hole, which had apparently been dug beforehand by her for the reception of her prey. As nearly as I could estimate it, she had directed her course in the first instance about ten feet on one side of her "objective point." Having at length succeeded in finding the hole, she proceeded to enlarge it, having previously laid the worm down, which was alive but not lively. She then went in backwards, dragging the worm in after her, and staid underground rather less than a minute. At the end of this time she re-appeared, of course without the worm, and began to fill up the excavation, ramming in the loose earth with her head. There was not quite enough loose dirt round the mouth of the hole to fill it completely up, there being about one-eighth of an inch in depth still unfilled after using all the excavated materials. I was curious to see whether she would be careful enough to supply the deficiency, so that no insect foe might be guided to the spot, where she had taken so much pains to deposit the cutworm as food for her future offspring I was not disappointed. In a very short time she commenced digging a second hole with her jaws, about an inch away from the first; and with the dirt that came out of this she filled up the first hole so that not the least vestige of it remained. Just as the operation was completed, I caught the wasp and preserved her in my collection duly labeled, according to my custom.

I subsequently dug into the spot where the cutworm had been buried, and found the worm about two and a half inches below the surface of the ground, with an egg attached to it near its middle. This cutworm I placed, egg and all, in a small jar along with some damp earth; and on emptying out the contents of the jar eighteen days afterwards, I found that the worm was completely consumed, and that the larva of the wasp had spun itself up in a cocoon. Whether or not I shall succeed in breeding the perfect wasp from this larva in 1869, remains to be proved.

Almost all the numerous species belonging to the above genus (*Ammophila*), the habits of which are known, provision their nests, like our new species, with caterpillars; only one or two species employing spiders, either normally or occasionally, for this purpose. We might quote many similar cases in other genera of Digger Wasps; and in all of them we may see interesting examples of the great law of the UNITY OF HABITS.

In No. 6 of the AMERICAN ENTOMOLOGIST, page 111, we gave a figure of the Tarantula of Texas (*Mygale Hentzii*, Girard), and an account from the pen of Dr. Lincecum of Texas of the mode in which it is captured, and stung so as to completely paralyze it, by a gigantic Digger Wasp (*Pepsis* [*pompilus*] *formosa*, Say); after which it is deposited, as provision for the future larva of the mother-wasp, in a hole which she digs for that purpose in the ground. We pre-

[Fig. 101]



Colors—Bluish-green; wings rufous and dusky.

sent herewith a figure of this Tarantula-killer, as it is commonly called in Texas; and we append an account of its mode of preying upon the Tarantula, by Mr. S. B. Buckley of Texas, which was printed in the *Proceedings* of the Philadelphia Entomological Society six years before Dr. Lincecum wrote on the subject.* This account embodies several particulars, which have not previously appeared in our columns.

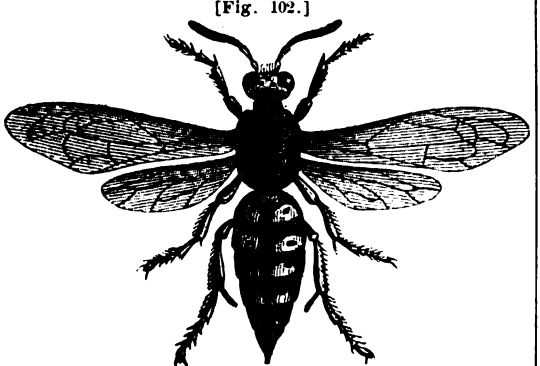
* Vol. I, pp. 138-9.

The Tarantula-killer is a bustling unquiet insect, always in motion, flying now here, now there, and when running on the ground its wings are in a constant state of vibration. Should it discover a Tarantula, it begins instantly to fly in circles in the air around its victim. The spider, as if knowing its fate, trembles violently, standing up and making a show of fight, but the resistance is very feeble and of no avail. The spider's foe soon discovers a favorable moment and darts upon the Tarantula whom it wounds with its sting, and again commences flying in circles. The injured spider is thrown into a tremor and often becomes paralyzed, though the infliction of a second and even a third wound is sometimes necessary. Sooner or later the spider becomes powerless, when the victor approaches, carefully feeling its way to see if its work has been effectually performed. It then begins to drag the Tarantula into a hole which it has previously dug in the ground, where, after the deposition of its egg by the wasp, the spider is covered up and allowed to remain.

I once met with one of these wasps that had just killed a large Tarantula. This was in central Texas, in midsummer, when no rain had fallen for a long time and the prairie soil was filled with numerous sun-cracks. The weight of the spider was at least three times that of the wasp, yet the wasp running backwards dragged it along through the dry grass which offered considerable resistance, overcoming every obstacle by earnest perseverance. The route was rendered still more difficult by the cracks in the soil, down which both occasionally tumbled; and several times I thought that the Tarantula was lost at the bottom of a crack, but both would soon again emerge. I had never seen such an exhibition of strength and perseverance even among ants. I watched for half an hour, much interested, the energetic wasp dragging the spider through cracks and over fallen weeds and through fences, and I followed, determined to see the result, although it was near sunset and I was distant from our encampment. After going a short distance, the wasp and spider fell into a large crack. I was then sure that the spider had been lost. After a little I bent down to see what had become of them, and was much surprised at seeing the wasp dragging the spider from the crack. At such an exhibition of strength, I inadvertently exclaimed aloud, "You are a stout fellow!" This exclamation caused the wasp to drop the spider and gaze at me for a moment, having then for the first time noticed me. It then flew three or four times around the spider, as if to mark its locality, and went away. Sorry for its departure, I took the spider to our tent and preserved it in alcohol.

In the first number of the AMERICAN ENTOMOLOGIST (pages 8 and 9) we referred briefly, on the authority of Benj. Borden, a respectable

[Fig. 102.]



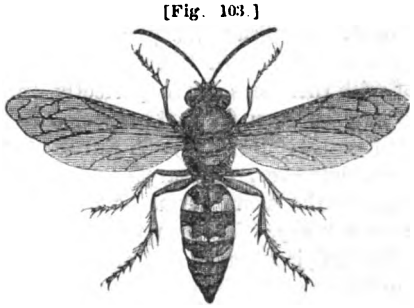
Colors—Yellow and rust-red.

Quaker farmer of Norristown, Pennsylvania, to the Gigantic Digger-wasp (*Stizus grandis*, Say) Figure 102, provisioning its nest with a *Cicada* (Locust). We repeat here the figure given in our first number, and quote at full length what Mr. Borden told us on the subject:

In the summer of 1866 my attention was called to a colony of large wasps or hornets near this town. A company of us armed with pick and shovel paid them a visit. They were located on the side of a stone turnpike. They burrowed in towards the center of the road. Hard ground appeared to be no obstacle, and when they encountered a stone they turned and went around it. Their burrows were about three feet long, with two or three galleries about one foot long. Each gallery terminated in a chamber considerably enlarged. In each of these chambers they appeared to have reared one young. We did not find any larva, but we found several in the pupa state. Also in each chamber we found the remains of one of our common locusts (*Cicada*). This locust in our section is considerably larger than the 17-year locust. The burrows were just large enough to admit this locust. One person had witnessed the operation of taking in a locust. The wasp had him on the top of the fence, and flew off with him, but came to the ground before reaching the burrow. Then by means of a hook on each of his hind feet he dragged his prey in on its back. We captured a few of the insects, and I placed one under a tumbler, but he chafed himself to death directly. They make a coarse humming noise when on the wing. I subsequently ascertained the scientific name of the species (*Stizus grandis*, Say) through Isaac Lea, President of the Academy of Natural Sciences at Philadelphia. A person tells me that he once attempted to capture a Summer Locust as it was sitting upon a post, but just as he made a grab at it one of these large wasps pounced upon it, and he caught them both at the same time, and got stung in the finger by the wasp in consequence. The puncture was so large as to cause blood to flow freely, and the pain was very severe, but gradually passed off without any serious inconvenience.

Mr. Borden was the first person to discover that the Gigantic Digger Wasp (*Stizus grandis*) provisions its nest with a *Cicada;* but an allied species, which is much commoner, the Handsome Digger Wasp (*Stizus speciosus*, Drury), Figure

[Fig. 103.]



Colors—Black and cream-color.

103, has been published by many different writers during the last century, as having the very same habits.* This species we know to occur in South Illinois; the fine female specimen, from which the above figure was drawn, having been captured in 1868, in Union county, by Mr. T. A. E. Holcomb, and obligingly presented to us. Whether Dr. Hull's observations upon certain gigantic wasps, of which "he and his sons, and his hired men, see one or two every year, flying along with considerable difficulty with a locust (*Cicada*) in their grasp,"* apply to this last species, or to the other one, is for the present uncertain. Of the large and superbly

*See *American Entomologist*, I, page 9.

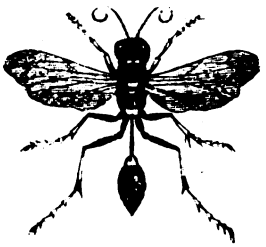
colored genus to which both insects belong (*Stizus*), but three species have hitherto been discovered in North America. We give in the Appendix a description of a fourth species of this same genus, the "Short-winged Digger Wasp" (*Stizus brevipennis*, n. sp.), of which but a single specimen exists in the cabinet of the Senior Editor, and none at all, so far as is known, in any other collection of insects.

The holes or nests dug in the earth by Digger Wasps are, for the most part—especially in loose, sandy soils—dug in the same manner as Mr. Smith's Blue Wasp effaced all traces of its nest, namely, by scratching with their front legs, and scrabbling the loose dirt backward with their four hind legs, the motions being performed with the rapidity of lightning But, as we saw above in the case of Dr. Packard's and Mr. Holcomb's wasps, certain species occasionally use their jaws in digging, and more especially, perhaps, when the soil is hard and solid; but, as a rule, they dig with their front legs, and not with their jaws, and scrabble the loosened dirt backward with their hind legs. Hence, we can see at once, why most species of Digger Wasps, and more particularly the females, which have the actual work to do, have their legs garnished plentifully—as has been already stated, and as will be seen at once in the wasps that are figured above—with long, stiff bristles, or slender thorns. On the other hand, the True Wasps, which, when they dig at all, dig with their powerful jaws, and not with their legs, have perfectly smooth legs, as may be seen from the species figured below (Figures 110, 111, 112). A European Digger Wasp, however, (*Ammophila sabulosa*)—belonging to the same genus as our Painted-wing Digger Wasp, (Fig. 100), which as we saw, digs with its jaws and not with its legs—although it has very bristly legs, is recorded as using the long, sickle-shaped jaws, which are characteristic of the genus, both in burrowing and in carrying the sand out of its burrow; thus approximating the habits of the Digger Wasps to those of the True Wasps.* So true is it, that in Entomology there is scarcely a single general rule without its exception, and that, wherever we open the great Book of Nature, and whether we study the structure of insects, or their habits, we find almost everywhere intermediate grades, and connecting links.

The comparatively few Digger Wasps that make their nests in timber, also have legs more or less densely armed with the usual bristles and thorns, because it is necessary for them to be able to scrabble the minute fragments of wood out of the holes, which they gnaw in the substance of the wood to serve as nests for their larvæ. In a single stick of partially decayed firewood, we once found in the winter several dozen of the nests of a small species of Wood Wasp (*Crabro*), from which in the ensuing summer we bred about a dozen of the perfect wasps.

And now we approach a great mystery. The genus of Digger Wasps known as *Pelopœus* (in English "mud-maker"), to which appertains the common Mud-dauber (*Pelopœus lunatus*, Fabr.) shown in Figure 104, and well known to make the so-called "mud-dabs" so often found in out buildings, does not dig at all either in earth or in wood.* On the contrary, it constructs its nests of tempered clay, affixing them to the interior of any buildings to which it has free access, or to overhanging cliffs. In search of moist clay for this purpose, it may often be seen, during a long dry spell of summer weather, perched on the ground in the neighborhood of wells and other places where water is habitually slopped upon clayey ground. We should naturally expect, therefore, that, as it has the same habits as many of the True Wasps, it would have the smooth legs of a True Wasp and not those of a Digger Wasp. No such thing. The legs of the female Mud-dauber are obviously bristly, though not so strongly as in the two most nearly allied genera (*Sphex* and *Ammophila*), both of which are known to burrow in the earth. But why should they be so, when the bristles are of no manner of use to her, any more than they would be to a True Wasp? One school of philosophers will reply, that its legs are bristly, because ages and ages ago, in the dim far-away vista of bygone geological years, the genus took its gradual origin from some species that did really dig holes in the ground, and had bristly legs to enable it to do so; and that, in consequence of the disuse of its bristles for generation after generation through myriads of geological ages, the bristles themselves have

[Fig. 104.]



Colors—Black and dull yellow.

*See Westwood, *Trans. Entom. Soc. London*, I, p. 200.

*There is a Blue Mud-dauber (*Pelopœus cœruleus*, Linn.), common in certain Northern States but very rare in North Illinois, which strongly resembles at first sight the Blue Digger Wasp figured above, (Fig. 97). It may be readily distinguished, however, from the latter, by the different veining of its front wings and by its smooth legs. Respecting the interminable confusion among our different N. A. Blue Wasps, see the Appendix.

gradually become shorter weaker and less numerous. Another school of philosophers will maintain, that its legs are bristly, in order to complete the Plan of the Creation, and carry out the System of Nature, and give full and free expression to the Thoughts of the Creator. Which explanation be the more rational and intelligible, the reader must judge for himself.

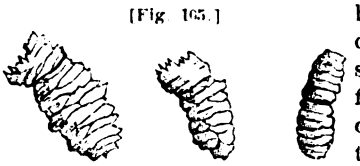
Two other such cases, which may be explained upon similar principles, have been briefly referred to by Dr. Packard in his *Guide to the Study of Insects* (pp. 165 and 169). In these cases two species, belonging respectively to two genera of Digger Wasps (*Larrada* and *Sphex*), all the other known species of which burrow in the ground to form their nests and have legs covered with thorns and bristles, have been ascertained to make their nests above ground in the fold of a leaf. We might consequently expect them both, if they were both primordially created with such abnormal instincts, to have perfectly smooth legs like the True Wasp (*Eumenes*) figured below (Fig. 110, *a*), which generally attaches its nest to the stem of some weed or to a leaf in the open air. It is pretty nearly but not exactly so; for it is recorded that one of these insects has its front legs perfectly smooth, and that the other one (the *Sphex*) has its front legs almost but not quite destitute of spines and bristles. We have but to refer to the sketch of a different species of this latter genus (*Sphex*) given above in Figure 99, the Ichneumon-like Digger Wasp, which species is known to be a burrower in the ground, to see how very differently its front legs are armed. The difference can be explained in the mode that best suits the reader.

But, from discoveries of our own, we are enabled to point out still another link in the chain which connects the Digger Wasps with the True Wasps, and still another thread in the complicated web which binds together all living organisms, whether animal or vegetable. There is a genus, or, as Mr. Cresson considers it, a sub-genus (*Agenia*) of the Spider Wasps (*Pompilus* sub-family)—a very extensive group of the Digger Wasps, all the other genera of which, with a single exception, to be hereafter noticed, burrow in the ground to form their nests, and have thorny and bristly legs. This genus (*Agenia*), however, has perfectly smooth legs, with the exception of a very few species, which have the merest rudiments of bristles or thorns, on their thighs or shanks. Singular to relate, although the French entomologist, St. Fargeau, has described thirty-five species of these smooth-legged Spider Wasps, found in various parts of the world, and although our countryman, Cresson, has described as many as twenty-eight species, found in North America, yet, up to this day, nobody can tell for certain what are the general habits of the genus, from anything that has as yet been published. Shuckard, judging from the structure of its legs, guesses that it must bore into wood to make its nest.* St. Fargeau, for the same reason, guesses that these smooth-legged Spider Wasps must be what may be called "Guest Wasps," building no nests of their own, but depositing their eggs, like the European Cuckoo and our American Cow-bird, in the well-provisioned nests of allied nest-building species.† The real truth of the matter is, that they are neither Wood-borers nor "Guest Wasps;" but make little "mud-dabs" of their own, usually under the bark of standing trees, or under prostrate logs, in which, precisely as does the well-known Mud-dauber, figured above (Fig. 104), they rear their young. Hence, we see at once why, like this last-named wasp, they have smooth, or very nearly smooth, legs. The reason is simple. Thorns and bristles on their legs, though of great service for digging nests in the ground, or in decayed wood, would be of no manner of use to them in building nests with mud; and therefore, they either have none at all, or mere rudimental ones.

Why certain species have rudimental thorns on their legs, may be explained in either of the two modes referred to above. Why, on the other hand, certain other species have perfectly smooth legs, we can readily understand if we adopt the former of these two hypotheses; but, if we adopt the latter hypothesis, this fact becomes an insoluble and unintelligible enigma.

We present herewith sketches drawn from nature, of the "mud-cells" made by four distinct species of this very remarkable genus, which, hitherto, has been such a puzzle to the entomological student. All four kinds of cells are occasionally connected together, end to end,

[Fig. 105.]



a *b* *c*

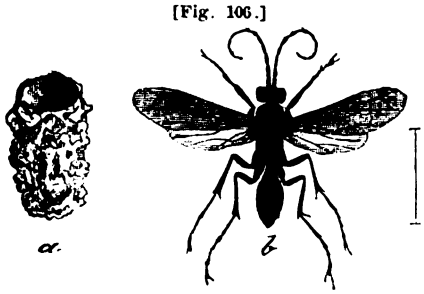
Color—Clay-yellow.

like a string of beads, as shown in the figures of three of them. These three, *a*, *b*, and *c*, are given in Figure 105, and the fourth in Figure 106, *a*, all of them of the natural size; and along with the fourth mud-cell, we give an enlarged drawing of

*Quoted by Westwood, *Introduction*, II, p. 208.
†St. Fargeau, *Hymenopteres*, III, p. 441.

the female of the wasp (*Agenia bombycina*, Cresson), Figure 106, *b*, that constructs it. From

[Fig. 106.]



Colors—(*a*) clay-yellow; (*b*) dingy black.

these four different kinds of mud-cells, we have bred specimens of the four different species of Spider Wasp (*Agenia*) that build them, three of which are described species, and one (*Ag. subcorticalis*), a new and hitherto undescribed species. This last is considerably the smallest of the four, and its nest, which we have always found exclusively under the loose bark of standing trees, is shown in Figure 105, *c*. The next largest species is one which was described thirty-two years ago by Thos. Say (*Agenia* [*pompilus*] *architectus*); and it is very remarkable that, although he gives a very elaborate description of the mud-cells from which he bred it, he says not a single word about the smoothness of its legs, and refers it to the same genus (*Pompilus*), to which belong the closely allied species with strongly-armed legs. We may add that Say found the mud-cells, from which he bred his specimens of this insect, "under prostrate logs and stones," while we found our two mud-cells under the loose bark of standing trees. The largest species but one (*Ag. mellipes*), was described by Say at the same time as the other one, merely from captured specimens, and without any knowledge of its habits, or any notice of its legs being smooth. This species we have also bred from mud-cells found exclusively under the bark of standing trees. Finally, the largest species of the four (*Ag. bombycina*), Figure 106, *b*, was described only two years ago by Mr. Cresson, without any knowledge whatever of its habits. This last we have bred in large numbers from mud-cells found under prostrate logs in North Illinois, and four specimens from similar mud-cells found under the bark of a standing tree in South Illinois. Unlike the other three, it has very small rudimental spines—scarcely perceptible except under the lens—on its legs. In the Appendix will be found a full description of the new species of smooth-legged Digger Wasps referred to above, and a few other details relative to this singular genus (*Agenia*), which would not interest the general reader.

It may be objected perhaps by the entomological purist that, as all these builders of mu-dcells, including the common Mud-dauber (Fig. 104) never dig at all, either in the ground or in decayed timber, or any where else, it is incorrect to call them "Digger Wasps." But a general name must not be changed because it is inapplicable to particular species. Many Bark-lice, for example, do not inhabit the bark but the leaves of plants; for instance the Scale-insect of the Oleander (*Aspidiotus nerii*, Bouche). Yet this last is none the less a true Bark-louse (*Coccus* family). Again, we have seen with our own eyes the common Bed-bug (*Acanthia lectularia*, Linn) actually swarming, not in beds frequented by Christians, but in a chicken-house. Yet any precisian who should insist that, when it infested a chicken-house, it ceased to be a "bed-bug" and became a "chicken-bug," would be simply ridiculous. Upon the same principle, a smooth-legged Spider Wasp does not cease to be a true Digger Wasp, because it never digs.

Not being aware of the habits of these small smooth-legged Digger Wasps, any more than anybody else, and being misled by certain misstatements as to the origin of our common American "mud-dabs," Westwood has advanced the erroneous opinion, that "it is only among the Bees and (True) Wasps that we find the habit of constructing nests with materials brought from a distance."* This habit, it is true, is the exception and not the rule among the Digger Wasps. We find it more common among such of the True Wasps as are solitary in their habits. But when we come to the most intelligent and highly-developed of the whole group—namely, such of the True Wasps as are social and live in large communities—we find it universal. Undoubtedly this practice displays great intelligence, and is as wonderful as the proceedings of most birds in building their nests with materials fetched from a distance. It is interesting, therefore, to observe here and there the first developments of this curious instinct among the lower Wasps—its gradually becoming more common among such Wasps as approximate in their organization to the Social Wasps—and its full and complete culmination among the latter, which are universally considered as the highest and most intelligent of all the Wasps.

The mud-daubing Spider Wasps (*Agenia*) are not exempt from the attacks of parasites any

* Introduction, II. p. 207.

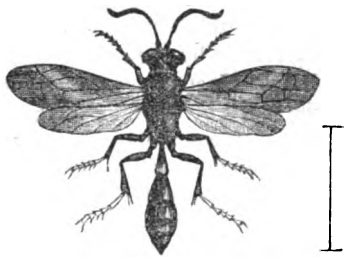
more than any other group of insects. From a lot of the kind of mud-cells sketched in Figure 105, *c*, we long ago bred great numbers of a minute *Chalcis* fly (*Pteromalus*) only one-twentieth of an inch long; and from a lot of those shown in Figure 105, *a*, about a dozen specimens of a beautiful undescribed Ichneumon-fly, about one-third of an inch long, banded with black and white, and with a white horse-shoe on the hind part of its thorax, to which we have given the manuscript name of the Horse-shoe Ichneumon-fly (*Mesostenus ferrum-equinum*).

It is well known to entomologists that among the solitary Bees—whose habit it is to provision their nests with pollen, and not, after the fashion of the Digger Wasps and solitary True Wasps, with living insects—there are many genera, physically incapacitated from collecting pollen, which lay their eggs surreptitiously in the nests of the true pollen-collecting Bees, and thus appropriate for their own offspring the rich stores laid up for another's. Not only in the case of the group of Spider Wasps just now referred to (*Agenia*), but in that of several other genera of Digger Wasps (*Trypoxylon*, *Pelopœus* and *Sapyga*), has a similar habit been inferred by several authors to prevail. We suspect that, in these particular cases, erroneous inferences have been drawn from seeing the supposed Guest Wasps entering old last year's nests made by true Digger Wasps, or by Bees, which nests they afterwards appropriate for their own use, having first in many instances repaired and remodeled them. As regards the first of the three genera enumerated above (*Trypoxylon*), Westwood has shown this to be so;* and, at the risk of being tedious, we will give some additional proofs of this and certain other analogous facts, which have been observed by ourselves for a long series of years.

Almost every American knows the so-called "mud-dabs," constructed by the common Mud-dauber (Fig. 104), to be composed of one or more layers or tiers of clay tubes, arranged side by side like a set of "Pan's pipes," and cemented on to some surface pretty well protected from the weather. In a particular locality—the rocky cliffs near Black Hawk's Watch-tower, in Rock Island county, Ills.—we have always, for many years back, found these "mud-dabs" to contain in the winter months the cocoons of the wasp that makes them, and those of another Digger Wasp of a uniform black color, and belonging to a very distinct family (*Trypoxylon albitarse*, Fabr). Figure 107, promiscuously intermixed in about equal proportions. There can be no mistake

* *Introduction*, &c., II., p. 194.

[Fig. 107.]



Colors—Polished black, with the hind paws whitish.

here, because the cocoon of the former, after stripping off the thin semi-opaque flossy outer membrane, characteristic of all those made by Digger-wasps, is about eight-tenths of an inch long, elongate oval, five times as long as wide, of a shining transparent tawny color, as thin almost as gold-beater's skin, and with the tail end docked, thickened and blackened; while the cocoon of the latter has a mere vestige of outer membrane, and is only about half an inch long, only thrice as long as wide, cylindrical but often with the head end expanding, like a cooper's rivet, into a more or less wide flange, of a dull opaque black color except the head end, which is ash gray, with the tail end docked but not otherwise differing from the rest of the cocoon, and the whole of a pretty firm and solid consistence. In most cases the elongate mud-cell of the Mud-dauber, when it has been tenanted by the Black Wasp spoken of above, is partitioned off by a clay diaphragm in the middle into two cells, each of which contains a distinct cocoon; but occasionally such a cell contains but a single cocoon, especially when the cell is rather shorter than usual. It is well known that the Mud-dauber provisions its nest with spiders, and fragments more or less complete of spiders may often be found in the cells occupied by its cocoons. Precisely the same thing occurs in the cells tenanted by the cocoons of the Black Wasp, showing that its larva must have fed upon spiders just as does that of the Mud-dauber. Lastly, from the cocoons shaped like a cooper's rivet, isolated in a separate vessel, we have repeatedly bred, not the Mud-dauber (Fig. 104), but the Black Wasp (Fig. 107).

Now, here is a mass of evidence amounting to what lawyers would call *prima facie* proof, that this Black Wasp is really a Guest-wasp, not building and provisioning any nest for itself, but laying its eggs in the nest built and provisioned by the Mud-dauber, and thus fraudulently appropriating for its own future progeny, the provision of spiders, laid up for the progeny of the Mud-dauber, by that poor hard-working industrious insect. Otherwise, why should the

two kinds of cocoon be promiscuously intermixed? Why should both kinds of larvæ be fed upon spiders? Why should the clay-cell, in which the Black Wasp rears its young, be so manifestly the work of the Mud-dauber, that no difference whatever can be perceived between those tenanted by the two different kinds of cocoon, save the clay partition in the middle, usually found, when the cell contains the cocoons of the Black Wasp, but never found when it contains the cocoon of the Mud-dauber? Most naturalists are tolerably well satisfied with evidence as strong as this; and for many years it staggered and puzzled us.

In the spring of 1867, we determined, if possible, to solve the enigma. We procured a very large quantity of the "Mud-dabs," containing both kinds of cocoons, and examined them at home, at our leisure. Thus we arrived at the following results, each of which will be accompanied by the proofs that establish it.

1st. *The Mud-dauber, as well as the Black Wasp, must often make use of the old last year's mud-cells constructed by the former.*—In two "mud-dabs" where there was a double tier of cells—the outer one of course not built previously to the inner one, for the simple reason that the inner one formed the foundation-wall for it—we found on March 9th, 1867, *in the outer tier*, dead and dry Digger Wasps in the perfect or winged state. Hence it follows that *the outer* tier must have been constructed at least as early as the summer of 1865; for if constructed in the summer of 1866 its cells would necessarily, on March 9th, 1867, have contained larvæ nearly ready to change to pupæ, or at all events pupæ, and not living winged wasps, and still less dead and dried up wasps. Consequently, *the inner tier*, having been built before the outer tier as already shown, must also have been constructed at least as early as the summer of 1865. But that inner tier on March 9th, 1867, contained at least one fresh cocoon of the Mud-dauber, as well as numerous fresh cocoons of the Black Wasp, intermixed together; and therefore both kinds of cocoon must have taken their origin from eggs deposited in the summer of 1866 in old cells which, as has been already proved, were built at least as early as the summer of 1865 and perhaps a year or two sooner. Thus, as both the Mud-dauber and the Black Wasp are proved to make use, occasionally at all events, of the old last year's cells of the former, the promiscuous occurrence of their cocoons is easily explained.

2nd. *The Black Wasp provisions its nest with different genera of spiders from those used by the Mud-Dauber.*—It occasionally happens with most Digger Wasps, that the egg fails to hatch out; or the larva, having hatched out, perishes from unknown causes at an early age. In these cases, therefore, the food stored up for the larva remains uneaten, or mostly uneaten. By diligent search, we found two such cells, which had manifestly been provisioned by the Black Wasp, because each formed the inner portion of a full-sized cell, divided in two by the usual partition, and the outer portion of it contained the cocoon of a Black Wasp. Emptying out into hot water the dead spiders contained in these two cells, which were in a fair state of preservation, and also, a few in tolerably good order, found at the bottom of some cells tenanted by the cocoons of the Black Wasp, we found them to be seventeen in number, and all of them to belong to one genus and species, except two, which, apparently, belonged to a different species of the same genus. It remained to ascertain what species of spiders were used by the Mud-Dauber. For this purpose, it evidently would not answer to examine the contents of a cell without any partition in the middle, and in which the egg or young larva had perished prematurely, *provided it was found in the same locality as the above.* For, as the Black Wasp occasionally erects no partition-wall in the cell which it occupies, there would then have been no certainty which insect of the two had provisioned it with spiders. Consequently, we examined "mud-dabs" from a locality where they are never tenanted by the Black Wasp; and having found several cells in them full of nothing but spiders, from causes already explained, we ascertained that these spiders, which were thirty in number, apparently belonged to, at least, four different genera, the number of individuals belonging to each genus, being respectively, 1, 6, 6, and 17; and that they were all, not only specifically, but generically, distinct from those found in the cells tenanted by the Black Wasp. We may add further, that some seven or eight more or less imperfect specimens, found in cells occupied by the cocoons of the Mud-Dauber in the first lot of "mud-dabs," all apparently belonged to the genus most numerously represented in the second lot of "mud-dabs."

3rd. *Other genera of wasps, besides the Black Wasp referred to above, occasionally use the second-hand cells of the Mud-dauber as a nest for their larvæ.* In a large mass containing numerous cells, occupied partly by cocoons of the Mud-dauber and partly by those of the Black Wasp,

we found a single large cell divided by a partition into two small cells, each of which contained what was evidently the cocoon, not of a Digger Wasp but of a True Wasp. Now, the larva of this wasp had manifestly been provisioned with caterpillars and not with spiders; for each cell contained eight or ten of the empty skins of some moth-larva or other upon which the wasp-larva had fed. Consequently, as the Mud-dauber provisions its nest, not with caterpillars but with spiders, the wasp that provisioned these two cells must evidently have catered for its own offspring. It was probably from some such case as this that Palisot de Beauvois, as quoted by Westwood, was deceived into stating that the Mud-dauber sometimes provisions its nest with spiders, sometimes with caterpillars.* We have opened hundreds and hundreds of their nests, and we are sure that they invariably use spiders for this purpose.

It may be added that, in all probability, the two larvæ of True Wasps, just now stated to have been discovered by us in Mud-dauber cells, would have developed into the Fraternal Wasp (*Eumenes fraterna*, Say) which will be found figured below (Fig. 110, *a*); for we had long before this period bred from common "mud-dabs" three males of this very same species. We cannot, however, speak positively as to this question; for we had to strip the cocoon off one of these two larvæ in order to examine it, after which it of course perished; and from the other larva there subsequently hatched out on May 19th, not the wasp itself, but a pretty blue parasitic fly (*Chrysis bella*, Cresson) common in North Illinois, which had preyed upon the larva of the Wasp. Not improbably, it was from some such occurrence as the above, that Mr. Saunders led Professor Westwood into the erroneous belief, that "mud-dabs" were really made by the same genus of True Wasps (*Eumenes*) to which the Fraternal Wasp actually bred by us from "mud-dabs" appertains; and that the veritable Mud-daubers (*Pelopœus*) were merely parasites, or rather Guest-Wasps, sponging upon True Wasps for food and lodging.†

In illustration of the curious propensity of the Black Wasp (Fig. 107), spoken of above, to habitually build and provision its nest in the old deserted nests of the Mud-dauber, we may quote here a very similar case observed in South America with regard to another species of the very same genus (*Trypoxylon*). For calling our attention to this case we are indebted to the kindness of Baron Osten Sacken, of New York city: "Mr. Clark found in Brazil, that *Trypoxylon fugax* closed with clay the cells of a nest of *Polistes*, thus using them for its progeny." * *Polistes*, we may add here, is a genus of social True Wasps, which will be found figured below along with its nest. (Fig. 112, *a*). According to Linnæus, whose assertions were subsequently confirmed by the researches of Westwood, the common practice in Europe of this genus of Digger Wasps (*Trypoxylon*)—the name of which is most unfortunately derived from two Greek words signifying "timber-borer"—is, not to bore into timber at all, but to take possession of holes in wood that have been previously made by other insects, and occasionally hollow straws, and therein to construct its nests. †

Seeing, therefore, that it seems to be a well-established fact, that the habits of this genus of Digger Wasps are, neither to burrow in the ground nor in wood, but to seek out ready-made holes or the old nests of other Digger Wasps for its nest, finishing them off with a little mud that it fetches there itself; we might naturally expect to find its legs either perfectly smooth or very nearly so. Now, what are the facts? They are actually quite smooth, and this character has been duly recorded by St. Fargeau, who, however, draws the erroneous inference therefrom that the genus has the habits of a Guest-wasp.‡

On the whole, therefore, as we have shown that at least two distinct genera of wasps (*Trypoxylon*, and *Eumenes*,) sometimes use the old second-hand cells of the Mud-dauber to build their own nests in, under circumstances which would mislead most naturalists into supposing that they were true Guest-wasps; and as all the recorded cases of so-called Guest-wasps that we have met with, are explainable upon similar suppositions, we incline to believe that no author has yet made out a clear and satisfactory case of the existence of such a thing as a true Guest-wasp, though undoubtedly there are many true Guest-bees, Guest-gallflies, Guest-sawflies, Guest-beetles and Guest-gallgnats. A true Guest-insect—or "*Inquiline*," as it is technically termed—deposits its egg in the recent nest of another insect, and appropriates for the use of the larva, that afterwards hatches out from that egg, the supply of nourishment provided by the mother-insect that makes the nest; the egg or the very young larva of this last mother-insect being afterwards often starved out

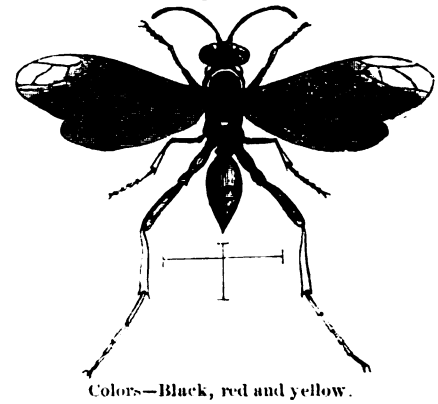
* See Westwood's *Introduction, etc.*, II, p. 206.
† See Westwood's *Introduction, etc.*, II, p. 207.

* From a paper by Mr. Smith in *Proc. London Entom. Soc* IV, p. 77, 1858.
† Westwood, Introduction etc., II, pp. 104-5.
‡ St. Fargeau, *Hymenopteres*, III, p. 225.

or otherwise destroyed by the intruder. But this is a very different thing—as will be seen at once—from making use of an old second-hand abandoned and unprovisioned nest, constructed years ago by some other insect, and provisioning it afresh. Our American Cowbird always deposits its eggs in the recent nests of other birds, leaving its future offspring to be cared for by another. But it would be a very different thing, if it merely took the old abandoned last year's nests of those birds, and provided its own self for its own family therein.

But, although we do not believe that any of the genera of Digger Wasps (*Trypoxylon*, *Pelopœus*, *Agenia*, and *Sapyga*), hitherto inferred by certain authors to have the habits of Guest-wasps, do really have those habits, yet there is one remarkable genus (*Ceropales*), belonging to the Spider-wasp (*Pompilus*) family among the Digger Wasps, which most certainly has. Hitherto nothing whatever has been positively known as to the habits of this genus, although St. Fargeau long ago asserted with regard to it, that he had often observed females enter backwards into nests constructed by true Digger Wasps, whence he inferred that it had the habits of a Guest-wasp.* But St. Fargeau is so flighty and fanciful an author, and he has told so many similar tales about other Digger Wasps,† which we now know to be not Guest-wasps, but to build nests of their own, that his evidence would not amount to much, if there were any reliable facts to controvert his opinion. And indeed, even if the facts that he fancied that he witnessed were just as he represented them to have been, they scarcely justify his inference. Luckily, however, for the scientific reputation of the French entomologist, we have a fact to bring forward which demonstrates that—in this instance, at all events—he was a good guesser. The fact is this: We have already mentioned having bred four specimens of a little Mud-dauber (*Agenia bombycina*, Cresson), sketched in Figure 106, *b*, from clay cells obtained in South Illinois. Of these clay-cells we obtained in November, 1867, five specimens, all alike, and all of them found in company under the bark of the same tree, near South Pass in South Illinois. From these five cells there hatched out, about the end of June, 1868, the four little Mud-daubers just now referred to, and a single male specimen of a beautiful and hitherto undescribed species of the remarkable genus of Spider-wasps (*Ceropales*), already asserted by us to have the habits of a Guest-wasp. The inference is unavoidable—more especially as we had previously bred very numerous specimens of the same little Mud-dauber from the same kind of mud-cells obtained in North Illinois—that this gaily dressed Spider wasp (*Ceropales*) had, some time in the summer of 1867, laid an egg in one of the five mud-cells found in South Illinois, and thus appropriated to the use of its future larva the supply of food laid up by the provident care of the unfortunate, dingy-looking little Mud-dauber for its own offspring. Otherwise it is impossible to account for two distinct kinds of Wasp hatching out from the same lot of mud-cells. Several years before this, we had captured at large, in North Illinois three females of this very same Spider Wasp, which are if possible still more beautiful than the male. From one of these the annexed highly magnified sketch (Fig. 108), has been drawn, in preference to drawing from the male; for the

[Fig. 108.]



Colors—Black, red and yellow.

females of the Digger Wasps, as stated before, always have their legs more bristly and spinous than the males of the same species, and it is desirable that the reader should see with his own eyes the armature of these important organs, in the sex where it is most highly developed. This genus, we may add, is especially remarkable—as may be seen in the engraving—for having hind legs of the most extravagant and disproportionate length. In the Appendix will be found a full description of our new species—which we have named the Red-bellied Spider Wasp (*Ceropales rufiventris*)—and a few other scientific details in regard to this interesting group, the true habits of which may now be considered as for the first time definitively settled.

Some authors have supposed that certain species of Digger Wasps open their nests from time to time, to furnish their young larvæ with fresh supplies of the appropriate food. But both St. Fargeau and Westwood discredit such state-

* St. Fargeau, *Encyl. Meth.* X., p. 183, quoted by Westwood, *Introd. etc*, II., p. 209.

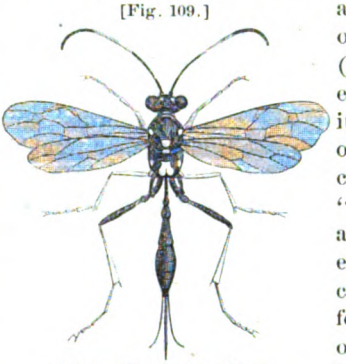
† For example, about the genus *Agenia*, or as he names it, *Anoplius*, *Hymenopt.* III., pp. 441-2; about the genus *Trypoxylon*, *ibid* p. 225; etc.

ments, the latter correctly remarking that "none but *social* insects feed their larvæ periodically."* Strictly speaking, the Digger Wasps do not feed their larvæ at all. They collect suitable food into a suitable nest, lay an egg therein, close up the nest, and then leave it forever. As a general rule, it is only the higher animals that feed and tend their young after they are born. All mammals, and almost all birds do this, while it is done by but very few reptiles and by still fewer fishes. Consequently, as the Social Insects (Honey-bees, Hornets, Yellow-jackets, Ants and White Ants) have this propensity, and, as any one may see by disturbing an Ant's nest, are as much attached to their larvæ as a mother is to her child, we may justly, *so far as this character goes*, consider them as superior to other insects. But any mode of classification, founded *exclusively* upon this one single character, would be open to the same objection as certain modern Systems of Classification broached of late years in this country, and founded exclusively upon a single character; namely, that they are artificial and not natural systems.

It may not be amiss to remark here, that there is a small group of Digger Wasps (*Mutilla* sub-family), the females of which have not even the slightest vestiges of wings, and strongly resemble ants, for which they are often mistaken by young entomologists. They may be distinguished, however, at once from any of the Ants by their antennæ not being flail-shaped, or "geniculate" as it is technically termed. From the great dissimilarity of the females to the males, some excellent entomologists were formerly in certain cases deceived into referring the two sexes, not only to distinct species but to distinct genera; and the very same thing has occurred with another genus (*Myzine*) belonging to an allied group (*Scolia* family), where the sexes are indeed both of them winged, but differ widely from each other in certain structural peculiarities. Through the kindness of Dr. Plummer, of Rock Island, Ills., who served in the medical corps of our army during the late war, we received several years ago from the State of Mississippi a large scarlet and black species of this sub-family, about three-quarters of an inch long (*Mutilla coccinea*, Fabr.), the sting of which is said to be peculiarly powerful and virulent in its effects. The females of those species, which have been seen by us when alive, are always found in sandy localities running about like ants; and such is said to be the general habit of the whole group. The males occur on flowers and shrubbery, and are very difficult to identify with their appropriate females, unless actually taken in copulation.

Although so snugly secluded from the world —each in his own private and peculiar cell, and with an abundant supply of delicious insect-meat close to his very mouth—the larvæ of the Digger Wasps do not escape the attacks of those universal marauders, the Ichneumon-flies and their allies. For example, besides the two parasites already referred to above as infesting the little mud-daubers (*Agenia*), a beautiful Ichneumon-fly (*Cryptus junceus*, Cresson)—represented in Figure 109 (♀) and remarkable for having when alive the peculiar and to us very agreeable smell of a Humble-bee (*Bombus*)—often pierces with its long tail-like ovipositor our common large "mud-dabs," and deposits an egg in the carcass of the unfortunate larva of the Mud-dauber. From this egg the larva very soon afterwards hatches out and finally, as usual, consumes the vitals of its victim, and subsequently spins itself up in a cocoon. We have ourselves bred the above Ichneumon-fly from these "mud-dabs," and have repeatedly found its thin white silken cocoon, with the larva inside it, in the clay-cell of the Mud-dauber. Thus the spider preys upon flies, the mud-dauber upon the spider, and the ichneumon-fly upon the mud-dauber. "Kill and be killed; eat and be eaten." This is the great universal law of Nature. Every insect is checked and controlled by the attacks of others. None, as a general rule, except when man by his artificial processes interferes with the wise arrangements of Nature, is ever allowed to become unduly numerous. Every being in the world, not excluding even the human species, exists, not only for its own pleasure and benefit, but for the pleasure and benefit of other and often very inferior animals. Nothing in nature exists for itself alone; nothing is wasted. Even the dried up remains of the doomed spiders, upon which the larva of the Mud-dauber has fed, are not allowed to go to waste; but are preyed upon quite extensively by the larva of a small beetle (*Trogoderma ornatum*, Say), belonging to a Family (*Dermestes*), several species of which

[Fig. 109.]



Colors—Black and yellow.

* Westwood, *Introduction, etc.*, II., p. 207; St. Fargeau, *Hymenopt.* II., p. 569.

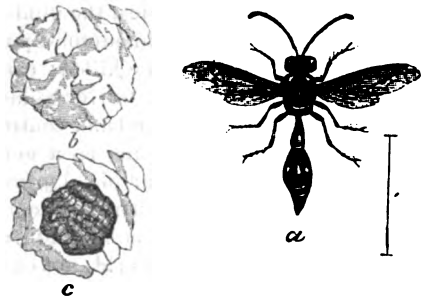
often infest badly kept collections of insects.

It is very remarkable that, although all the Digger Wasps feed in the larva state upon living animal matter, they all of them in the perfect or winged state feed exclusively upon vegetable substances, such as the honey and pollen of flowers. Hence it is the more wonderful, that they should be impelled by nature to store up for their future offspring a supply of such food, as would be utterly distasteful to themselves.

The True Wasps—Solitary Species.

The solitary True Wasps scarcely differ in their habits from the Digger Wasps, except that such genera (*Odynerus*, etc.) as construct their nests in sandy banks, in the interstices of stone walls, in holes bored by other insects in wood, etc., never dig with their two front legs, or scrabble out the excavated fragments with their four hind legs, after the usual fashion of the Digger Wasps. On the contrary, they always excavate their holes solely with their powerful jaws, having first, when they are boring into hard earth, softened it with their saliva; and they always carry the excavated fragments out with their mouths, instead of scrabbling them out with their legs.* The reason is obvious: their legs, as stated above, are smooth, and, therefore, not adapted for digging, scratching and scrabbling. Many genera, however, construct mud-nests in the open air, and we present herewith a sketch from nature (Figure 110, *b*), of

[Fig. 110.]



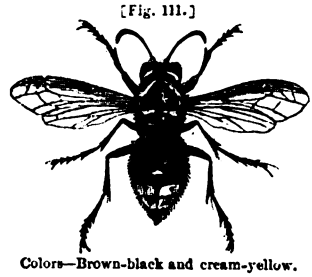
Colors—(*a*) black and yellow; (*b*) mud-color; (*c*) mud-color and green.

that built by a common North American species, belonging to such a genus—the Fraternal Wasp (*Eumenes fraterna*, Say, Fig. 110, *a*). Figure 110, *c*, shows the same nest cut open shortly after it was built, so as to display the close and compact manner in which the small green caterpillars, with which it was stored, are arranged by the mother-wasp. According to Harris,* the Fraternal Wasp employs the pernicious cankerworms (*Anisopteryx vernata*, Peck) for this purpose; but it certainly can never do so near Rock Island, Ills., for there are no cankerworms in that neighborhood, and yet this wasp is very abundant there. The nest itself is sometimes firmly cemented under the loose bark of a tree, sometimes attached to the stem of a large weed in the open air, and sometimes to a leaf. We possess the leaf of some deciduous plant sent us by a correspondent, which exhibits no less than five of these nests, all placed close together on its lower surface, and from one of these the perfect insect was actually bred. So that, in this latter case, it would seem that the nests would necessarily all fall to the ground in the winter, and the larva—which does not hatch out into the perfect wasp state until the summer after that in which the nest was built—would be exposed all through the inclement season of the year to lie soaking on the ground after every storm of rain or snow. Possibly, however—as we know that the larvæ of many moths will, under such circumstances, fasten the leaf, or leaves, to which their cocoons are attached, by silken cords to the twig—the mother-wasp, in this case, might have taken the precaution to cement the leaf to the twig by the same clay mortar of which it constructs its nest.

The True Wasps—Social Species.

The Bald-faced Hornet (*Vespa maculata*, Linn, Fig. 111), is so well known throughout the Northern States, that it may be taken as a familiar example of the habits of this group.

[Fig. 111.]



Colors—Brown-black and cream-yellow.

"Natural paper-makers from the beginning of time," as Harris has felicitously called them, these insects have, for ages immemorial, done what man, with all his boasted pre-eminence in intellectual power, has only succeeded in doing within the last few years; that is, they manufacture paper, not out of rags, but out of wood. Alighting upon some wooden surface exposed to the weather, they gnaw off with their strong jaws the minute filaments of wood, which have become partly detached by the action of the elements, and chew them up into a fine pulp, which they afterwards spread out into the thin sheets of

*See, on this subject, St. Fargeau, *Hymenopt.*, II, p. 550, and Reaumur, as quoted there—a far more reliable authority for the habits of any insect than St. Fargeau.

Injurious Insects, p. 271.

strong gray weather-proof paper that form the material of their nests. Generally these nests are suspended from the branches of trees, and some of them when completed are much larger than a man's head; but we have occasionally seen small nests attached to the lower surface of the rail of a tight board-fence, and we once met with a single full-sized one which was built in a weedy place so that it touched the surface of the ground. Each nest, whatever be its location, is suspended from some object above it by a single strong pillar, its external shape being globular or oval, and is covered by an outer envelop of many irregular layers of paper. Inside this envelop the combs or layers of hexagonal cells are placed—each suspended from the one above it by numerous little pillars of the same *papier maché* that the insect employs in all its architecture—thus leaving an open passage-way between the different tiers. These combs, constructed of the same paper-like substance, and not as in the case of the honey-bee of wax, differ further from those of the honey-bee in their horizontal position, and in containing each of them but a single layer of hexagonal cells, with their mouths opening downwards; whereas those of the honey-bee are well known to all bee-keepers to contain a double layer, with their mouths opening sideways, and each comb suspended in a perpendicular direction from the roof of the hive. In the case of the Bald-faced Hornet, the cells are used exclusively for rearing their larvæ in, each cell containing a single larva; while the honey-bee, as is notorious to every bee-man, uses some of its cells for this purpose, and some of them for the storage of honey to supply its necessities during the cold inclement winter months when no flowers are to be found. The two insects, it may be remarked, agree with each other in the singular habit of beginning at the top and building downwards; and the Laputan philosopher, mentioned in Gulliver's Travels, ingeniously proposed to imitate this peculiar feature in their architecture, by building the garrets of every house first of all, and then gradually working downwards to the lower stories and the cellar.

With the Social Wasps, as with all other social insects, there are no less than three distinct kinds of individuals, namely, Males, Females, and what used to be called "Neuters" or sometimes "Workers." In the case of the honey-bee, it was long ago conclusively proved that the workers, when deprived of their queen, take an egg which would otherwise develop under ordinary treatment into a common worker, and by placing it in a cell that is much larger and has its mouth opening downwards instead of sideways, and is always pear-shaped instead of hexagonally prismatic, and by feeding the young larva that hatches out from the egg with a peculiar food, develop that larva into a fertile female, or, as it is commonly called, a queen-bee. Hence it necessarily follows that, with the honey-bee, the workers are merely a peculiar kind of females, though they differ by certain invariable structural characters from the other kind, and there are no intermediate grades between the two. For this latter reason the two forms cannot be considered as mere varieties, the one of the other, but are clearly what naturalists now call "dimorphous forms." Of late years it has been further established by indisputable evidence, that certain workers among the honey-bees, without any sexual intercourse so far as is known with the males or drones, sometimes lay eggs which afterwards develop into complete males. Here, however, it is exclusively males that are thus generated; and as it has been shown by Siebold, a German naturalist, that the ordinary males of every hive proceed from unfertilized eggs laid by the queen-bee, we may infer by analogy that the males thus abnormally produced by worker-bees also proceed from unfertilized eggs. From all these facts, it follows that, in the case of the honey-bee at all events, the term "neuter," as applied to the worker, is clearly a misnomer.

So far as regards the Social Wasps, it has within the last few years been demonstrated in England, that Worker-wasps can and do generate other Worker-wasps, without any intercourse with the male sex.* Whether they can also generate, in the same manner, the so-called female wasps or queen wasps, and the male or drone wasps, remains to be proved; but we should not be surprised if it turns out that they can. For with many distinct Families of insects—for example, the Gall-flies, the Plant-lice, and certain Families of moths—it has been shown that several consecutive generations of fertile females may successively come into the world without any sexual connection whatever.† Be this as it may, it is quite clear that, both in the case of the honey-bee and in that of the Social

*See Stainton's *Entomologist's Annual* for 1861, pp. 37-39. It is proved by the experiments of several independent English observers, that in wasps' nests, from which the queen wasp was removed quite early in the spring, the generation of workers continues through the season as freely as if the queen wasp had been still present there to lay eggs. Therefore these newly generated workers must proceed from eggs laid by workers; and as no males or workers ever live through the winter and the males only make their appearance towards the autumn, these egg-laying workers could not possibly have been impregnated by intercourse with the opposite sex. It would be interesting to repeat these experiments with some of our American Social Wasps.

†On this recondite subject see the note in No. 6 of the AMERICAN ENTOMOLOGIST, p. 103.

Wasps, the term "neuters" must be abandoned, as leading to utterly erroneous and untenable ideas.

With all the Social Wasps, the males make their appearance only towards the autumn—say the latter end of August and during the month of September in North Illinois—as we know ourselves from long continued observations. The same fact was long ago noticed in Europe with regard to the species peculiar to that country. Shortly after the appearance of the males the large individuals called queen-wasps, which are destined to continue the race for another season, come all at once into the world. Copulation then takes place in the usual manner; but as soon as the cold weather commences the males and the workers all perish, while the queen-wasps retire to some secure spot and pass the winter in the torpid state, common at that season with almost all insects. In the case of our American Bald-faced Hornet, the queen-wasp excavates for herself a cell under some very rotten half-buried log, from which situation we have repeatedly disinterred her, in good robust vigorous health, in the early spring months. As soon as spring opens she sallies forth from her hiding-place, and each individual becomes the founder of a distinct nest, rearing nothing but workers at first, which, as soon as they are hatched out from their cells, unite with her in carrying on the labor of the community. Later in the season, the queen-wasps seldom, if ever, are seen abroad, and probably confine themselves to the nest like the queen-bee. Thus, as will be seen, every colony of Social Wasps is dissolved at the approach of winter, and every colony in the succeeding year takes its origin from a single female, that after being fertilized has passed the winter in a torpid state. The same rule holds good with the Humble-bees (*Bombus*). With the honey-bee, on the contrary, and with the various species of Ants (*Formica* family), there is no definite limit to the duration of a colony, the entire brood of workers surviving through the rigors of winter. We recollect disinterring in March a nest of one of our commonest black ants (*Myrmica lineolata*, Say), in which we found a mass of the workers clustered together in a round ball as big as a hen's egg, and enclosing in the midst of them quite a number of their larvæ, evidently with the view of protecting their soft white delicate bodies from the cold.

The more usual food of our Bald-faced Hornet seems to be the honey and pollen of flowers; but we have repeatedly observed them catching Two-winged Flies upon umbelliferous flowers, and chewing them up on the spot. Reasoning from the analogy of the Digger Wasps, which live themselves upon vegetable matter and rear their larvæ upon half-paralyzed insects and spiders, we may infer that insects chewed up in this manner are afterwards disgorged and fed out to the young larvæ in the nest at home; but it would be rather a difficult undertaking to prove the fact by direct evidence. Some persons in America have turned this insect-devouring propensity of the Hornets to good purpose, by suspending one of their nests in a house much infested by the common house-fly. In such a situation, we have been told that they soon make a clearance of the obnoxious flies; and so long as you do not meddle with them, they will not meddle with you. But woe to any one who—as we have sometimes ourselves accidentally done in beating trees for insects—strikes against the sacred home of the hitherto contented and peaceful family! Better for him that he had been subjected to the surgical process of acupuncture! for the needles of the surgeon are not envenomed, and the sting of the infuriated Hornet is bathed in liquid fire.

In no case, as authors have observed, even when, as in the instance of certain European species, Social Wasps catch and devour honey-bees, do they sting the insects that they catch, after the fashion of the Digger Wasps, and of such of the True Wasps as are solitary, and not social in their habits.* The two latter groups sting captured bees, not because they are afraid of being stung in return by them, but in order to make them lie quiet while the soft, white, helpless larva of the wasp is eating slowly and gradually into their vitals, perhaps three or four weeks after their capture. The Social Wasps, on the contrary, have no occasion to follow this practice, for they feed their larvæ personally from day to day, until those larvæ have matured; and therefore, they have no occasion to lay up a store of living meat for their helpless offspring, in the manner already described as practised by the Digger Wasps. In fact, all insects that capture bees and wasps, know perfectly well how to hold their prisoners in such a position that the sting cannot be used with effect. We have more than once seen one of the gigantic, soft-bodied, buzzing, two-winged *Asilus* flies (Order *Diptera*), that prey so ravenously on other insects, grasping a large Social Wasp (*Polistes*), or a good-sized Humble-bee by the head end, as if at arm's

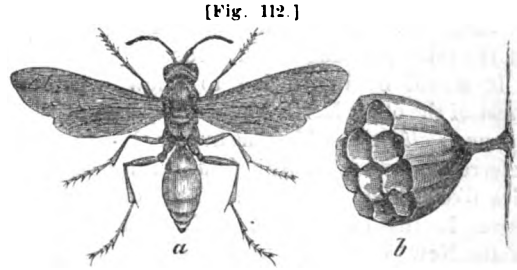
*This assertion is confirmed by St. Fargeau, speaking of European species, *Hymenopt*, I, p. 481.

length, by means of its own front legs and stout beak, while the end that contained the sting was vainly beating the air away out ahead, and the *Asilus* Fly was gradually sucking out the vitals of the doomed insect with grim and silent satisfaction. We have also seen the same skillful tactics often practiced by a small, robust black and yellow bug, about one-third of an inch long (*Phymata erosa*, Fabr.)—common everywhere in the northern States, and found even in the streets of New York City—which haunts flowers, and preys habitually upon small bees and wasps. On the other hand, when an *Asilus* Fly captures a common grasshopper, we have remarked with astonishment, tnat it takes no such precautions as the above, but holds the grasshopper underneath its own body, belly to belly, in such a way that it would be sure to get stung if its prey had any sting at all. Evidently these insects know the difference between a wasp and a grasshopper, and are well aware that one has got a sting and the other has not. And yet certain two-legged animals without feathers, who do not know the difference between a bee and a beetle, and who could not for the life of them hold a bee or a wasp in their fingers for one second, without getting badly stung, consider that all "Bugs," as they are facetiously pleased to call them, have got no sense at all, and are but little superior, in the scale of the creation, to the herbs of the field and the trees of the forest!

The insects commonly known as "Yellow-jackets" in the United States belong to the same genus (*Vespa*) as the Bald-faced Hornet, and of course like that species are social in their habits and have the same general characteristics. We have a great many species of them in this country, differing by slight but invariable peculiarities of size shape and coloration, and there are two (*V. vulgaris* and *V. germanica*) which are supposed by Saussure to be identical with European species. We ourselves know but little of their economy, save that all the species with which we are acquainted build their nests underground likethe Common Wasp (*Vespa vulgaris*), of Europe, and none of them attach their nests to trees, as do certain European species. As we should naturally expect, from their belonging to the same genus, their nests are built upon the same principle as those of their ally, the Bald-faced Hornet. St. Fargeau records the fact that—as we should anticipate from the smoothness of their legs and the robustness of their jaws (*mandibles*)—such European species as burrow in the ground use their jaws, and not their legs, in burrowing and in carrying out the excavated material.*

There is another genus of Social Wasps in North America (*Polistes*), about as numerous in species as that to which the Bald-faced Hornet and the various kinds of Yellow-jackets belong, and distinguishable at once from that genus by being much slenderer, and by having the first segment of the abdomen separated by a slight "constriction" from the second segment, as if a thread had been tied tightly round the connecting suture. They build combs, precisely similar to those of the Bald-faced Hornet, in some spot partially sheltered from the weather, but always without any paper envelope, and usually with but a single comb to a nest. What is very remarkable, and does not appear to have been hitherto animadverted on by any author, whether European or American, all known European species construct these combs in a vertical direction, like the honey-bee, attaching them laterally by their central point to some weed or shrub or building.† In Figure 112, *b*, may be seen a sketch of such

[Fig. 112.]



Colors—(*a*) rust-red; (*b*) gray.

a European nest, copied from Westwood. On the contrary, all our American species seem, as a rule, to build horizontal combs, just as does our Bald-faced Hornet, and all the European wasps and hornets that belong to the same genus as that insect. For example, the only American species of which we have personally observed the economy (*P. americanus*, Fabr.) builds a horizontal comb; in one case that came under our notice suspending it from the lintel of the doorway of an old ruinous house, and in the other case elevating it on the upper surface of the rail of a tight board fence. Thus, by the way, it results that, with this particular species, the cells must in one case have been built with their mouths downwards, and in the other case with their mouths upwards. Again, eight years ago we became aware that a large spe-

* *Hymenopteres*, I. pp. 488-9.

† As authorities for this assertion we may quote Westwood *Introduction*, II., p. 252: St. Fargeau, *Hymenopt* I., p. 492.

cies, the Rust-red Social Wasp (*Polistes rubiginosus*, St. Farg., Fig. 112, *a*), the sting of which we know by painful experience to resemble closely a large darning-needle heated to a white heat, built great numbers of nests in barns and other outbuildings in the town of Jonesboro in South Illinois. We therefore wrote to our good friend, Mr. Paul Frick of that town, to ask him to examine the timbers of his barn and report the results. In reply he informed us that he found great numbers of the Wasp's combs there, and that, as a general rule, they were suspended in a horizontal position from the lower surface of the beams of the building; "though," as he adds, "he has sometimes seen the comb attached to a rafter and placed obliquely, so as to correspond with the slant of the rafter from which it hangs." Thirdly, Mr. N. C. McLean, of Coles county, Ills., informs us that a species (probafrom his description *P. pallipes*, St. Farg.), which commonly builds nests under the eaves of his house, always builds horizontal combs, with the cells opening downwards. Lastly, Dr. Packard states, that three different species of this genus, with the economy of which he became personally very familiar in Virginia, all of them built their combs "with the mouths of the cells pointing downwards."*

It would be interesting to know whether most of the other North American species of this genus (*Polistes*) besides the five or six just now referred to, and most of the South American species likewise, adopt the same style of architecture. In that event, as the animals and plants of the New World are now generally allowed by naturalists to belong to a more ancient and old-fashioned type than those of the so-called Old World, we might assume that the American style of building is the normal and primordial one, and that the European style is a modern improvement upon it. Perhaps, in the course of indefinite ages, the Yellow-jackets and Hornets of Europe may improve in the same manner upon the antediluvian horizontal style of architecture, which is still universally followed on both sides of the Atlantic by all the species of the genus (*Vespa*) to which they belong, and may take to building vertical combs, like those highly civilized and highly developed Caucasians among the social insects—the honey-bees.

As to the diet of this genus (*Polistes*), it appears, like that of the Hornets and Yellow-jackets (*Vespa*), to be partly vegetable and partly animal. We once observed the same large rust-red species, which has been figured above, chewing up a green caterpillar some three-quarters of an inch long, as the wasp itself sate perched upon one of the limbs of a tree; but ordinarily these insects, like most other kinds of wasps, may be found flying from flower to flower in search of honey and pollen, and occasionally perhaps gobbling up some peculiarly sweet-scented and sweet-flavored "bug" or "worm." As in the case of the Bald-faced Hornet, the probability is that they catch insects as food for their young larvæ, first chewing them up into a kind of pap or pulp, and live themselves upon honey and pollen.

The females of the only two species of this genus (*Polistes*), that we have met with in North Illinois (*P. americanus*, Fabr., and *P. fuscatus*, Fabr.), we have noticed repeatedly to hybernate under the loose bark of standing trees; and in neither can we perceive any marked difference in the respective size or coloring of the hybernating females and the so-called workers found at large in profuse abundance in the middle of the summer. So that the distinction between these two forms seems to be here inappreciable to the eye, although, judging from the analogy of allied species carefully observed in Europe, it must have a real existence.

The following paragraphs from the pen of Mr. A. Fendler of Missouri, woich appeared about two years ago in the *Gardeners' Monthly*, prove that wasps are occasionally very beneficial to the farmer by carrying off caterpillars on a wholesale scale. From the circumstance that the wasps observed by him are stated to have "worked up their prey into a small ball," it is quite clear that they must have belonged to some of the social species; for none of the Solitary Wasps ever do this, for reasons which have been already explained. But to which of the two genera illustrated by us (*Vespa* and *Polistes*) they really appertained, is left uncertain. Perhaps species belonging to both genera may have united in the good work. Certainly these wasps must have belonged to one or the other genus referred to above; for, with the exception of a single species found exclusively in California (*Polybia flavitarsis* Sauss.), they are the only genera of Social Wasps that occur in the United States.

One of the most tedious kinds of work in raising a crop of tobacco is the turning over of every leaf in search of the caterpillar, known by the name of horn-worm or tobacco-worm, so very destructive to that crop.* These worms can be found of all sizes, from that of a sewing-needle's point to that of a man's finger.* * * * *

*Guide to the Study of Insects, p. 151.

*Most probably the larva of the Tobacco-worm moth (*Sphinx Carolina* Linn). The Potato-worm, which is the larva of a very closely allied species of moth, long confounded with the other one, but quite distinct from it

Last Summer, although these caterpillars were hatched in unusually large numbers and to an alarming extent, yet, rapid as their growth is, they never reached the size of more than one inch in length. The cause of this singular phenomenon I soon found to be a number of hornets, and orange-colored wasps, dispersed over the field, and busy from morning till night during the months of July and August, in searching for tobacco-worms on the lower side of the leaves. Whenever they found one, they took hold of him with their mandibles, *worked him up into a small ball*, and then carried him off. In this way the wasps check the development of the caterpillar.

Later in the season, in September, when the nights turn cool, the wasps are busy only during the warmer part of the day; hence many of the caterpillars have a chance of growing to full size, even if the tobacco is being wormed by hand. When they have reached the length of somewhat over an inch, they become too heavy for the wasp, and are rejected.

Whether the latter render their services to man from motives of self-interest or otherwise is quite immaterial to me. These little creatures, by their efficient and voluntary aid, imposed upon me a duty of gratitude which will not allow me to pry into their motives. They will always find in me a friend ready to protect them, no matter whether they meant to benefit me or themselves. Most likely they had the preservation of their own offspring in view, and thus work for the horticulturist's future benefit.

Some years the wasps seem to be less numerous than in other years. In this part of the country one acre of tobacco, in order to be properly wormed, requires most of one person's time and attention throughout the growing season, if he has no assistance. Last summer, assisted by wasps, the acre of tobacco I planted did not require more than three wormings, leaving me plenty of time for other work.

An article on the habits and natural history of this tribe of insects, by one of our entomologists, could not fail to be of much interest to the horticulturist.

CONCLUSION.

After this very imperfect sketch of the habits of the different groups of wasps found in this country, it only remains to recommend the subject to the further attention of careful observers. Since there are at least 500 species of wasps to be met with in the United States, the field is of course a pretty extensive one; and it will richly repay the toils of the laborer in curious facts and instructive deductions therefrom. We could have easily swelled this Paper to thrice its present somewhat unwieldy dimensions, by copying blindfold what has been said by European authors respecting the habits of European species; but we preferred to lay nothing before the reader that was not based upon personal observations by resident Americans of American species of Wasps, with the exception of a few incidental remarks and illustrations, all of which have been duly credited to the sources from which they were derived.

Most people abhor the very name of a Wasp, and considering them all as an unmitigated nuisance, destroy them without mercy wherever they can be found. Certain species—we are not accurately informed which, but, judging from the experience of our European brethren, we should infer them to be some kind or other of Social Wasps — do undoubtedly injure fruit in certain seasons, by boring holes in the pulp to gratify their natural taste for sugary substances. But even these catch a great many noxious insects; and the great bulk of the Wasps—that is to say, the Digger-wasps and the solitary True Wasps—have, we belive, no such mischievous propensity for attacking fruit, and, as a general rule, are beneficial to mankind by checking the undue increase of other insects, and more especially of Plant-lice, Grasshoppers, and leaf-feeding Caterpillars. By what has been said above, the reader will be enabled to distinguish the former group from the two latter groups; and when we know that the two latter groups are generally our friends and never our enemies, instead of being ruthlessly destroyed they should always be cherished and encouraged.

Owing to the great length of this article, the scientific appendix is deferred to number 8.

[NOTE.—We regret to have to apologize for the inferior character of some of the figures, illustrating this article. About a month ago our engraver was suddenly called away to the sick bed of a son, and we consequently sent our drawings to Philadelphia. The firm to which they were sent has done excellent work for us on previous occasions, and after finishing the drawings with great care, and giving full instructions, we felt assured of being satisfied. When the proofs came, however, we were much mortified at finding that all instructions had been ignored, and that much of the work had evidently been done by novices in their calling. It was then too late to have them re-engraved, and the best we could do was to have them worked over and corrected. We say this in no derogatory spirit, because our Philadelphia friends have an excellent reputation, and *can* do good work; and it is quite probable, that in their endeavors to please us, they hurried the work too much. But we have their own word for it, that the wood was good and the drawings excellent, and they justly deserve a word of censure. Please recollect, gentlemen, that the readers of the ENTOMOLOGIST are abundantly capable of discriminating between a good and a bad engraving, and that in their eyes, "bugs are not creatures of such hideous mien," that any kind of botch-work will do for them. Give us in future your very best talent.

(*Sphinx, quinque-maculata*, Haw.), and figured in all its stages in this Journal, page 21, sometimes infests tobacco, but more usually in the northern than in the southern States.